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By HENRY HARRISON SUPLEE,[2] NEW YORK, N. Y.

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The old-time coking plants, destroyed by the enemy, have been re-equipped with modern by-product coke ovens, producing ammonia, gas, and benzol.

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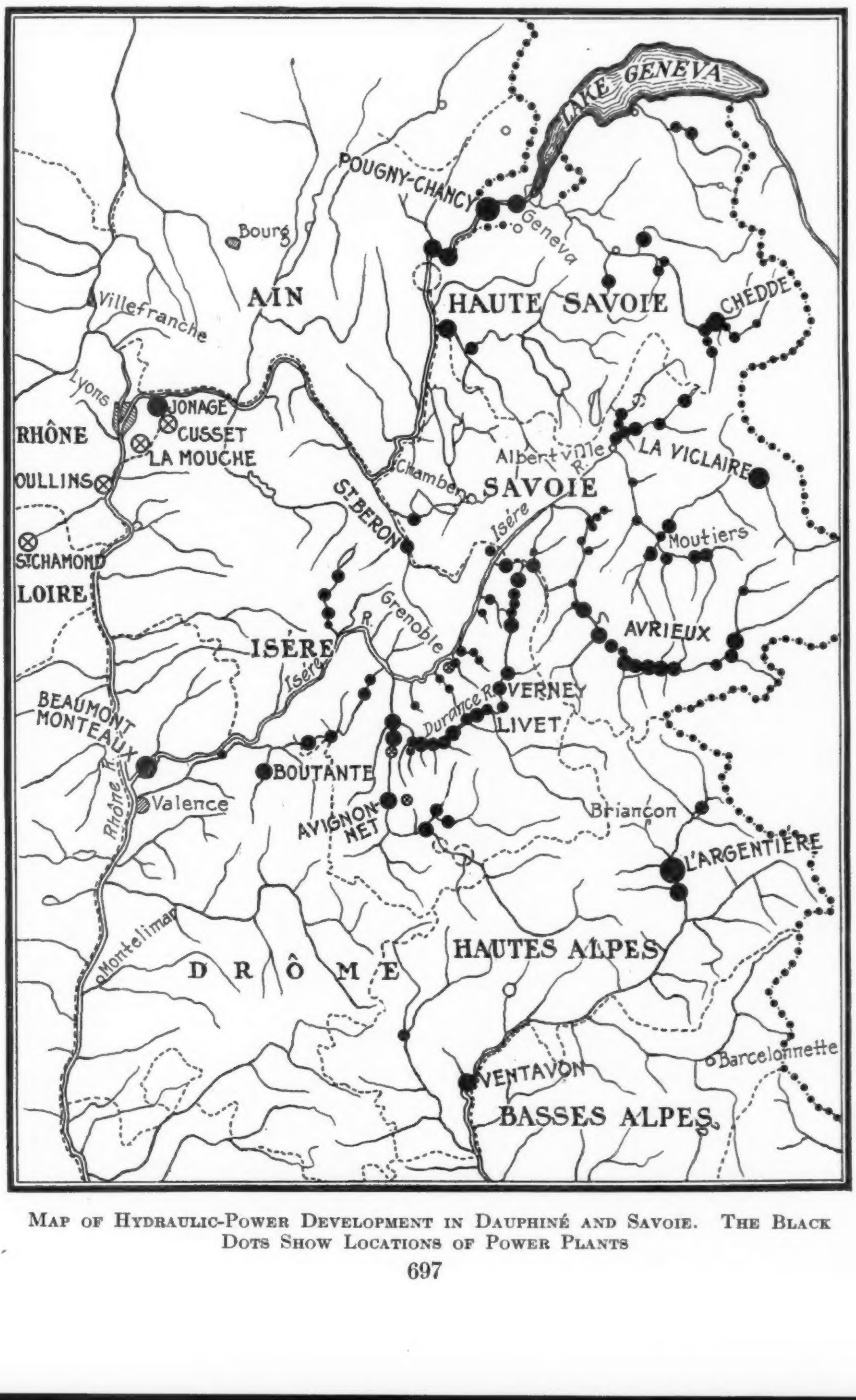
[2] Vice-President, Am. Section S.I.C.F.; Mem. A.S.M.E.



Map of Hydraulic-Power Development in Dauphiné and Savoie. The Black Dots Show Locations of Power Plants

Since coal is the principal source of power, it was with the coal-mining industry that reconstruction began.

The total coal requirements of France are about 75 to 80 million tons a year. Before the war about one-third of this had to be imported; by the close of the present year none need be imported; we shall soon see why.

All around the coal-mining districts were grouped the textile mills, whose products sent the results of the skill of French workmen over the world. Of these factories only the walls were left standing; all the equipment had been carried beyond the enemy frontier. Much of this equipment could not be reproduced; none of it could be recovered; but nearly ninety per cent of these textile factories are now in full operation, with new machinery of such improved type that the output is greater than ever before. The only limitation upon the growth of the industry is the lack of workers. In this, as in other lines, there is no unemployment in France.

Let us now turn to iron and steel.

Before 1870 France was one of the great iron-producing countries of Europe. Then she lost the ore fields of Lorraine, and was obliged to depend largely upon Normandy. Now Lorraine has been redeemed, and France is once more a great iron and steel nation. In 1913 less than five million tons of steel were made in France; during the war this fell to one-half that amount; last year nearly seven million tons of steel was the triumphant output.

Next to steel comes aluminum—the metal of the future, as the war test showed. Aluminum requires cheap bauxite and an abundance of cheap electricity. France has the natural deposits of bauxite in abundance, but not until these latter days has she had the electrical energy available. Now she has both, and can dominate the aluminum trade of the world.

Dauphiné, Valley of the Bourne

Dauphiné. Lodge on the Road to the Grand Chartreuse

Dauphiné. The Sarenne Cascade; Power Pipe Line in Upper Left

The Village of Oisans, Above Grenoble, and the Peaks of the Meije, 13,000 Ft. Above Sea Level

Grenoble, France. Distant View of the Alps

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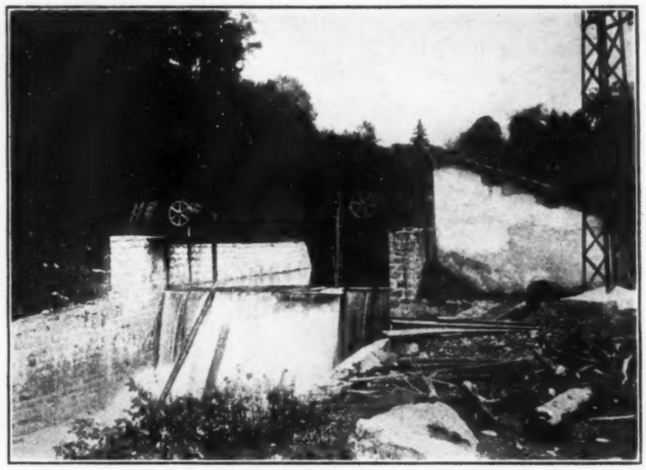

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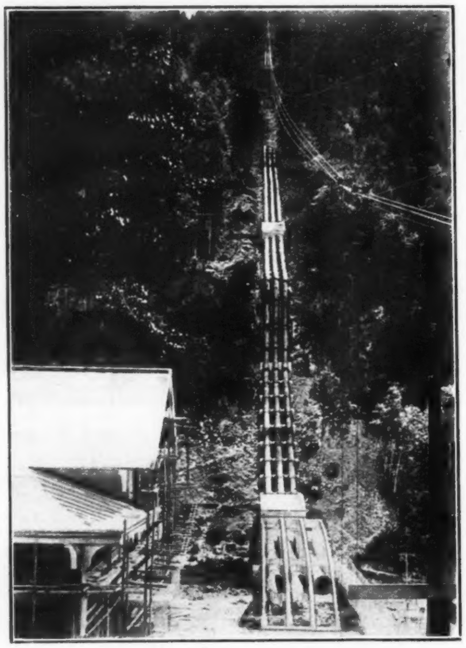
What about the railroads, the three thousand miles of main and local lines, wiped out, with their rolling stock, by the enemy in the ten occupied and devastated departments?

Within three years after the armistice all these had been rebuilt, and were actively bringing in material and supplies for the intensive reconstruction work. This meant the rebuilding of bridges, embankments, and stations; as well as the renewals upon the sadly overworked lines which had borne the war burden. Main-line electric traction is far advanced in the south, as we shall see later.

There is another phase of the reborn France which is scarcely appreciated. France has always been a land of water transport, and the tourist carries with him the picture of that gracious combination of glassy canals, long lines of Lombardy poplars, and the smooth white highway between; and as he rolls along in his motor car he sees the laden barges passing from river to river by the intersecting canals, and distributing merchandise everywhere with true French economy.



Penstocks for Miegebat Power House of the Chemin de Fer du Midi; 1265 Ft. Head, 50,000 Hp.

In France it has always been the desire of her statesmen to keep the land self-supporting; and what cannot be produced at home is brought from the colonies if possible.

We must not forget the tremendous potential resources included in the colonies of France, with an area, including the French Republic, nearly twice as large as the continent of Europe; fifty per cent larger than the whole of the United States, and with more than eighty per cent of our population.

The French farm has always been an institution peculiar to itself; its group of buildings, the homes of men, women, children, and animals, placed about and within an enclosure in which all are securely impounded when the heavy gate is closed for the night.

Our very word "farm" is the French word *ferme*—an inclosure.

Of these familiar and homelike farm houses, more than a hundred and fifty thousand had been destroyed by the invaders; a desolate sight for the widows and young children of their former owners, as they painfully clambered over the shell-sown quarries which had once been their fertile fields.

Today all these have been rebuilt; the eight million acres of fields have been cleared and put into cultivation, and French agriculture, still far short of men, is calling for electric power and modern science to meet her recovered demands.

Facts Regarding the Recovery of France

In summing up the facts about the recovery of France, nothing

Power Building for Baton Works. 3400 Ft. Head, 7000 Hp. Cut in Solid Rock. Two Additions Under Construction

View Showing the Dam of the Roberts Works. Romanche, Near Grenoble

better can be done than to quote from the remarkable report which the Commercial Counsellor of the British Embassy in France has made; a report which is so entirely unbiased and free from possibility of any ulterior purpose as to be especially worthy of acceptance.

Her ore-mining industry has recovered; her potash industry has got into its stride, and is increasing its exports to markets formerly possessed by Germany. The woolen, cotton, linen, and jute industries in these areas, all of which were severe sufferers in the war, have finished the reëquipment of their works, and have been producing to the full extent of their labor supply. The metallurgical, engineering, chemical, and miscellaneous industries of the same areas have likewise completed their reconstruction, and have been unusually active, especially since all misgivings relative to the coke, and therefore to the steel, supply were dissipated. Agriculture has made slower progress, partly owing to the still acute shortage of labor; but the chief crops—wheat and sugar beets—are regaining their former productivity, and a certain progress is observable in providing the country with live stock.

Garden About the Verney Power House

Construction Work on the Belleville Penstock—1675 Ft. Head

Viclaire Power House; 1300 Ft. Head, 24,000 Hp. To Be Doubled

Viclaire Dam on the Isère

Outside these areas the great trades have been, and are, equally prosperous. The Lyons silk trade, the lace trade of Calais and Caudry, the artificial silk trade, the Troyes hosiery trade, the Paris fancy-article and luxury-goods trades, the motor-vehicle industry in several centers, the watch trade at Besancon, the heavy chemical trades at Paris, Lyons, and elsewhere, the porcelain trade at Limoges, the bauxite production in the Var—these and the other great export trades all tell the same tale.

The prosperity of the country is amply attested by the continual stream of immigrant workers. For the last year the weekly arrival of about six thousand workers has been duly recorded; the actual number has probably been much greater, as coal miners and agricultural laborers, which are two classes in greatest demand, may enter the country without having to pass through the official records. These immigrants are mainly of Italian, Polish, Belgian, and Spanish nationalities, but the most diverse nations are represented.

Apart from the prosperous dynamic state of the French economy, it may also be noted that it has increased in a permanent fashion its industrial capacity, which is now far superior, from the material and technical standpoints, to that of 1914.

The natural resources have been increased by the acquisition of Alsatian ores, potash, and oil. Manufacturing power has been increased by the acquisition of highly developed and varied textile and engineering industries in Alsace, but far more through two main currents of expansion—namely, the wholesale reconstruction of nearly the entire range of textile industries, of coal and iron mines, metallurgical and engineering works, glass and chemical works, and so forth, in the devastated areas, and the movement of transplantation of industry from these regions, initiated during the war, which led to the employment of old, or the establishment of new, factories in the Lyons, Grenoble, Bordeaux, Rouen, and other localities throughout France.

Moreover, as in certain other countries, employers tended to devote a considerable portion of war profits to the extension and improvement of works. As a consequence, French manufacturing industry as a whole has modernized and newly equipped its undertakings on a large scale.

All these, and more, are the phases of the marvelous story of the recovery of France, but we must not forget that it has been accomplished by placing upon her people a terrific financial burden.

The industrious and economical peasantry of France, after the unparalleled strain of the war, has contributed to the execution of this work of re-creation more than one hundred billion francs!

At par of exchange, say, twenty cents to the franc, this would mean twenty billion dollars! At the varying rates of exchange during the period of reconstruction, probably the average would make it the equivalent of about seven billion dollars. This burden, principal and interest, France owes to her own people. No wonder she asks for time in which to adjust her external debt; but it is time only that she needs—her remade industries will surely be equal to the task.

While this work of reconstruction has been going on in the devastated departments, there has been conducted, in such a quiet manner as to attract little external notice, a remarkable development in a wholly different quarter.

A New Industrial District and Its "White Coal"

Far to the south, well away from exposure to the dreaded enemy frontier, there has been growing a new industrial district: new in character, new in principle, new in commercial connections.

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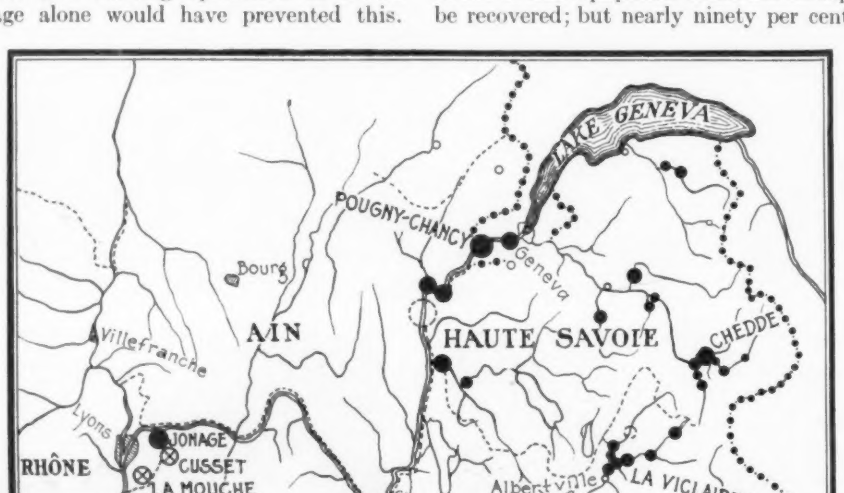

MAP OF HYDRAULIC-POWER DEVELOPMENT IN DAUPHINÉ AND SAVOIE. THE BLACK DOTS SHOW LOCATIONS OF POWER PLANTS

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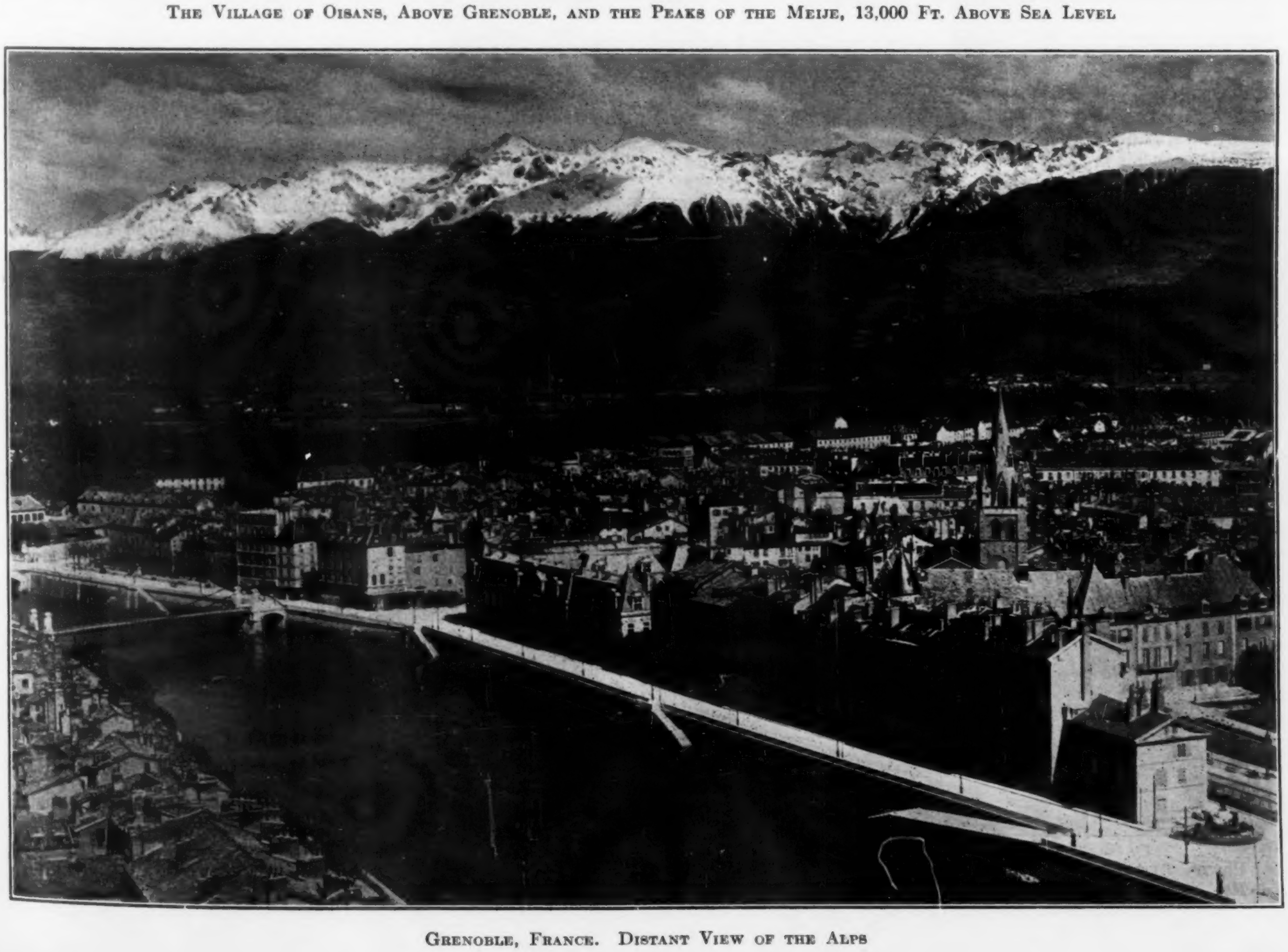

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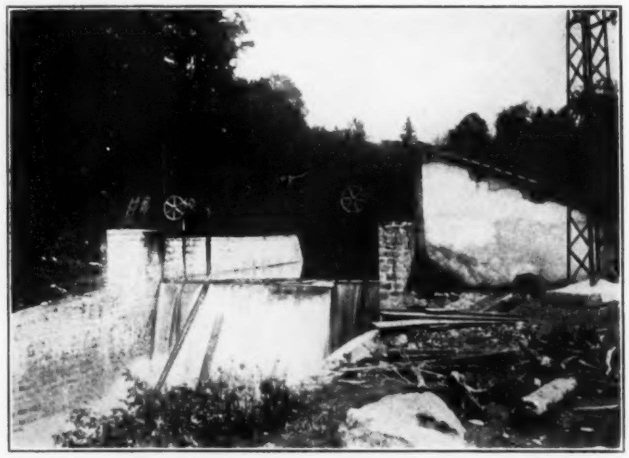

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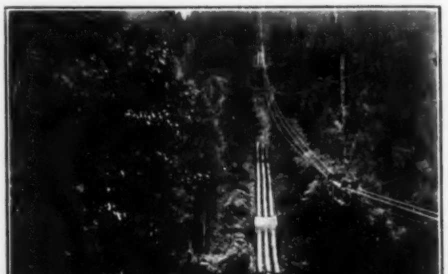

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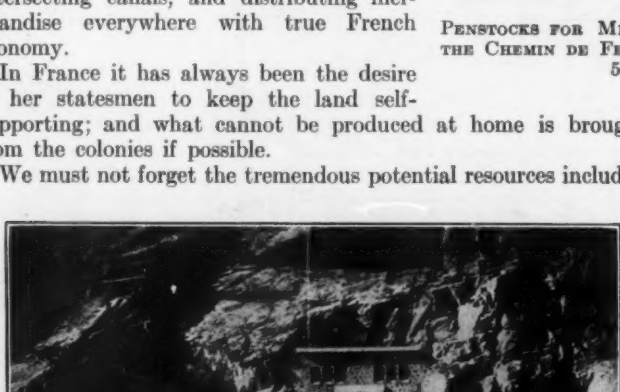
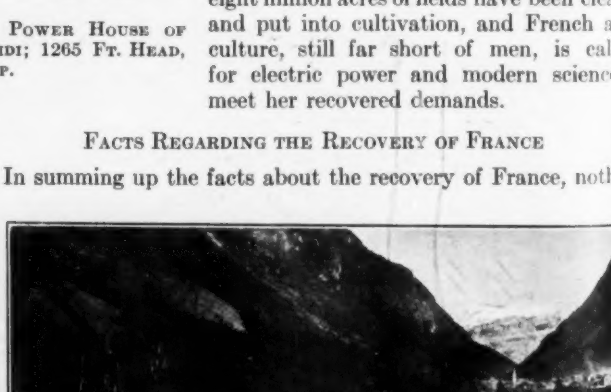


Power Building for Baton Works. 3400 Ft. Head, 7000 Hp. Cut in Solid Rock. Two Additions Under Construction



View Showing the Dam of the Roberts Works. Romanche, Near Grenoble

better can be done than to quote from the remarkable report which the Commercial Counsellor of the British Embassy in France has made; a report which is so entirely unbiased and free from possibility of any ulterior purpose as to be especially worthy of acceptance.

Her ore-mining industry has recovered; her potash industry has got into its stride, and is increasing its exports to markets formerly possessed by Germany. The woolen, cotton, linen, and jute industries in these areas, all of which were severe sufferers in the war, have finished the reëquipment of their works, and have been producing to the full extent of their labor supply. The metallurgical, engineering, chemical, and miscellaneous industries of the same areas have likewise completed their reconstruction, and have been unusually active, especially since all misgivings relative to the coke, and therefore to the steel, supply were dissipated. Agriculture has made slower progress, partly owing to the still acute shortage of labor; but the chief crops—wheat and sugar beets—are regaining their former productivity, and a certain progress is observable in providing the country with live stock.

Garden About the Verney Power House

Construction Work on the Belleville Penstock—1675 Ft. Head

Viclaire Power House; 1300 Ft. Head, 24,000 Hp. To Be Doubled

Viclaire Dam on the Isère

Outside these areas the great trades have been, and are, equally prosperous. The Lyons silk trade, the lace trade of Calais and Caudry, the artificial silk trade, the Troyes hosiery trade, the Paris fancy-article and luxury-goods trades, the motor-vehicle industry in several centers, the watch trade at Besancon, the heavy chemical trades at Paris, Lyons, and elsewhere, the porcelain trade at Limoges, the bauxite production in the Var—these and the other great export trades all tell the same tale.

The prosperity of the country is amply attested by the continual stream of immigrant workers. For the last year the weekly arrival of about six thousand workers has been duly recorded; the actual number has probably been much greater, as coal miners and agricultural laborers, which are two classes in greatest demand, may enter the country without having to pass through the official records. These immigrants are mainly of Italian, Polish, Belgian, and Spanish nationalities, but the most diverse nations are represented.

Apart from the prosperous dynamic state of the French economy, it may also be noted that it has increased in a permanent fashion its industrial capacity, which is now far superior, from the material and technical standpoints, to that of 1914.

The natural resources have been increased by the acquisition of Alsatian ores, potash, and oil. Manufacturing power has been increased by the acquisition of highly developed and varied textile and engineering industries in Alsace, but far more through two main currents of expansion—namely, the wholesale reconstruction of nearly the entire range of textile industries, of coal and iron mines, metallurgical and engineering works, glass and chemical works, and so forth, in the devastated areas, and the movement of transplantation of industry from these regions, initiated during the war, which led to the employment of old, or the establishment of new, factories in the Lyons, Grenoble, Bordeaux, Rouen, and other localities throughout France.

Moreover, as in certain other countries, employers tended to devote a considerable portion of war profits to the extension and improvement of works. As a consequence, French manufacturing industry as a whole has modernized and newly equipped its undertakings on a large scale.

All these, and more, are the phases of the marvelous story of the recovery of France, but we must not forget that it has been accomplished by placing upon her people a terrific financial burden.

The industrious and economical peasantry of France, after the unparalleled strain of the war, has contributed to the execution of this work of re-creation more than one hundred billion francs!

At par of exchange, say, twenty cents to the franc, this would mean twenty billion dollars! At the varying rates of exchange during the period of reconstruction, probably the average would make it the equivalent of about seven billion dollars. This burden, principal and interest, France owes to her own people. No wonder she asks for time in which to adjust her external debt; but it is time only that she needs—her remade industries will surely be equal to the task.

While this work of reconstruction has been going on in the devastated departments, there has been conducted, in such a quiet manner as to attract little external notice, a remarkable development in a wholly different quarter.

A New Industrial District and Its "White Coal"

Far to the south, well away from exposure to the dreaded enemy frontier, there has been growing a new industrial district: new in character, new in principle, new in commercial connections.

Before the Great War there had been in the province of Dauphiné three French engineers seeking power for the development of the paper-manufacturing industry of the region; Aristide Bergès, Alfred Fredet, and Amable Matussière. Of these three, the pioneer was Bergès, whose far-sighted vision perceived the power possibilities of the melting snows upon the Alpine mountain peaks about him. In this beautiful region coal was scarce and dear, but power was absolutely essential. It was Bergès who saw that the small volumes of water with the high heads available might be harnessed for motive power. Instead of the black coal brought up from the depths of the earth, he said: "Let us use this 'white coal' upon the mountain peaks about us!"

Starting in 1869, with a small installation under a head of 200 meters (about 650 feet), he progressed until by 1891 he was working with heads as great as 500 meters, or more than 1600 feet.

In the meantime Fredet and Matussière followed with similar installations, and the power possibilities of the region were demonstrated. Today there is in actual service in France a hydraulic power system of more than two-and-a-half million horsepower, releasing more than twenty million tons of coal a year. Since the hydraulic-power resources possible in France are estimated at ten million horsepower, it will be seen that one-fourth is already in service, and by the close of the present year this will be greatly exceeded.

Since this great source of power in nature is especially well situated for the industrial transformation which has been already mentioned, it takes on an importance far beyond its direct magnitude.

Here is abundant natural power available far away from the enemy frontier, directly in line with rail and water transport, not to the exposed sea ports of the North Sea, but to the ancient port of Marseilles, already greatly improved for this added traffic. This gives an outlet to the external world by way of the Mediterranean and the Straits of Gibraltar, guarded by a friendly power.

All this does not mean that this beautiful region of mountain and valley, of rivers and villages, has been defaced into a sordid manufacturing district. It was the genius of Bergès, Fredet, and Matussière which showed how the gentle melting of the "white coal" might be used free from offense.

Far up on the mountain side the small reservoir, the *chateau d'eau*, gathers the trickling water and leads it into the slender steel penstock, so skilfully led down to the valley that it is scarcely perceived. The graceful power houses only emphasize the beauty of their surroundings, and often they stand in the midst of parks and gardens. The power lines distribute the electric energy unobtrusively along the wooded hillsides; there is no smoke, no noise, no disfigurement of the landscape.

Already a great portion of the railway systems of the region are electrically operated by current produced from the white coal; soon the entire tourist travel from Paris through to the Cote d'Azur, the Riviera, will be drawn by electric locomotives on trains free from smoke and dust, needing no foreign coal.

All along the valleys of the Isère, the Drac, the Romanche, and other streams there are growing up centers of industry, works for electrometallurgy, electrochemistry, electroceramics. Calcium carbide, cyanimide, electrically refined steel, cement, paper pulp, and a long list of other products are being manufactured by the latest methods of creative chemistry.

More than a hundred years ago the work of the civil engineer was defined as the "art of directing the great sources of power in nature to the use and convenience of man."

The work of the military engineer may perhaps be similarly defined as the "art of directing the great sources of power in nature to the misuse and inconvenience of man!"

The Engineer's Service to France

Here the engineer has come to the service of France and has directed these hitherto unused sources of power to the restoration of the industries of the nation after a destructive war.

It was Huxley who said, in his presidential address to the British Association for the Advancement of Science, that the work of a single scientist, Louis Pasteur, had created more value for France than the whole of the five milliards of francs indemnity which she so promptly paid to Germany after 1870.

So the work of these pioneer engineers, Bergès, Fredet, and Matussière and their successors, is giving to France the resources she so sorely needs in place of the reparations lacking since 1918.

The engineer who passes through France today and sees about him the tense and almost feverish activity in industry, creating new wealth everywhere to meet the terrific burden carried by this brave nation, knows that France will carry through triumphantly.

The Plight of Industrial Designs

Every manufacturer and dealer whose products involve industrial designs, no matter how simple they may be, has a vital interest in legislation now pending in Congress which not only threatens the development of industrial art, but may seriously embarrass industry generally.

The substitution of copyright for patent protection for designs and the repeal of the design patent laws is the basic change embodied in this legislation, which is officially known as House Bill 6249. The change sounds simple enough, but owing to the fundamental difference between copyrights and patents, its effects are far-reaching.

The degree of protection afforded against infringement, for instance, will be much less than under the present patent laws. On the other hand, manufacturers, dealers, and the public generally will be confronted with the prospect of endless litigation under copyrights indiscriminately registered for designs which are not now entitled to protection at all, such as those lacking novelty or having merely a trivial character.

Taking a specific example, if a manufacturer developed at much expense a distinctive and very valuable industrial design and obtained a copyright registration for it, he would be unable to protect his design against any one else who later, independently and without copying, produced a design identical with his work. Such a manufacturer would have to share his market with the producers of the later design. Under these circumstances there will naturally be little inducement to manufacturers to spend large sums developing distinctive articles, only to have their designs duplicated later by competitors who would share in their commercial possibilities. Should such a manufacturer seek protection in the courts, he could not obtain relief under his copyright unless his competitor's design was in fact copied from his, and this would present an obviously difficult point for proof.

Another far-reaching effect of this proposed change will be that it will enable copyright monopolies to be created in designs which are now the property of any manufacturer who desires to use them. These indiscriminate copyright registrations will present a wide opportunity for harassing tactics and will breed much litigation.

Confusion of rights and consequent lawsuits will also grow out of the fact that the proposed change will make it possible for different persons to secure separate copyright registrations on identical designs. This would manifestly be a great hardship upon the one first producing such a design and copyrighting it. He and his trade might be confronted at any time with widespread competition developed under a later copyright.

One of the principal objects of the proposed change is to avoid the delay involved by examination in securing design patents. It is claimed that designs, if promptly marketed, may be copied by competitors, cheapened, and their value destroyed before patent rights can be obtained under which suit can be brought.

The need, if any, does not justify the radical departure proposed. The difficulty, if it exists, is not general, but applies only to particular cases. Doubtless relief could be obtained by appropriate changes in the present laws or their administration, but even now patents are promptly granted on designs which are not open to objection.

The sum and substance of the matter lies in the fact that copyright is not an appropriate form of protection for industrial designs, because it has been developed to deal with literature and the fine arts. Industrial designs, on account of their relation to the useful arts, involve conditions of a different kind and which are more analogous to those under patents than under copyrights.—John Dashill Myers, of the Philadelphia Bar.

Limiting Factors in Reducing Excess Air in Boiler Furnaces

A Study of the Interrelationship and Relative Importance of the Three Factors Most Closely Related to Excess Air: Namely, Furnace Temperature, Unburned Fuel, and Heat Loss in the Chimney Gases

By E. G. Bailey,[1] Cleveland, Ohio

Every one interested in the combustion of fuel in boiler furnaces realizes the importance of maintaining a low percentage of excess air. If the air for combustion is reduced to a point too close to the theoretical requirements for a given fuel, however, several other factors must be considered or else poorer efficiency and a higher operating cost will be encountered than if more excess air had been permitted.

The three factors most closely related to excess air are furnace temperature, unburned fuel, and heat loss in the chimney gases. There is also the effect upon superheated-steam temperature and the power required to handle the air to the furnaces and the products of combustion from the boilers. With given equipment and fan capacity the reduction in excess air has permitted operating the boilers at higher capacities.

The first three factors are the ones of greatest interest, and they are the ones which will be discussed particularly in this paper. The interrelationship between these factors is fundamental, and a study of their relative importance and consequence is of wide interest as it applies to all types of fuels, furnaces, and operation.

The reduction in excess air means higher furnace temperature—which in itself is a good point for combustion efficiency—but consideration must be given to the cost of furnace maintenance such as refractories, stoker parts, and burners, as well as to the formation of clinkers—all of which tend to increase the operating cost. A reduction in excess air beyond the point of the theoretical requirements will of course result in incomplete combustion of the fuel, and due to imperfect mixtures this costly result really begins to show itself long before the air has been reduced to what is known as the theoretical amount necessary for complete combustion.

By unburned fuel reference is made not only to CO and other combustible gases but also to carbon and smoke in the flue gases and combustible in the ashpit, all of which are more or less closely associated with the percentage of excess air.

Before the days of the combustion engineer and before the CO_2 recorder and other similar equipment were available, every fireman used his more or less good judgment in striving for the best percentage of excess air. He did not talk of CO_2 or excess air, but he used the expressions, "a hot fire," "keep the holes out of the fire," and "carry a fuel bed of the right thickness," giving little or no attention to the question of smoke.

The impression seems to be rather general that in olden days the biggest trouble was with excess air, but excess air prevailed in the plants that had plenty of draft, while a deficiency of air and unburned gases prevailed in plants that had limited stack or draft facilities.

During the past ten years the rapid development of mechanical stokers, pulverized coal, improved oil- and gas-burning equipment, and the study of the combustion problem have brought out very many interesting facts. Even in plants where combustion engineers were not continuously studying the problem, the operator has naturally tended to reach the most economical percentage of excess air through experience and observation, with smoke and refractory trouble on the one hand, and low steaming capacity and poor-looking fires as the result of excess air on the other.

During this period of time the author has been closely in touch with the situation, as combustion tests have been made under his direction in connection with the installation of about 4000 boiler meters recording the steam output, the air flow, and, in most cases, the flue-gas temperatures or other factors closely related to boiler and furnace operation. When the data thus obtained are classified and averaged for different fuels and different types of fuel-burning equipment, they have a very significant value in that they represent definite tendencies and relative characteristics, the same as does any mass of statistics compiled, whether relating to weather or the mortality of human life.

The data presented in this paper represent more than 75,000 complete flue-gas analyses taken across the last pass of the boiler, with due care being exercised to avoid errors due to stratification or air leakage. The Orsat apparatus was used for determining the CO_2, oxygen, and CO of each sample.

Data on Combustion Tests

Fig. 1 represents a summary of 3767 combustion tests classified as to fuel—coal, oil, and gas—coal being subdivided as to method of firing into hand fired, overfeed stokers, natural- and forced-draft chain-grate stokers, forced-draft underfeed stokers, and pulverized coal; while oil has been divided between steam-atomized and mechanical-atomized burners. These are arranged in order of the

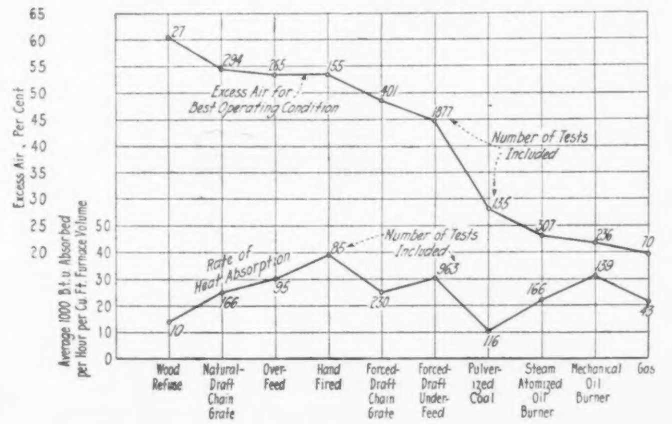


Fig. 1 Average Excess Air at Best Operating Conditions with Different Types of Fuel-Burning Equipment

diminishing percentage of excess air from the maximum of 61 per cent attributed to wood refuse, down through 45 per cent for underfeed stokers, 28 per cent for pulverized coal, and 19 per cent for gas-fired boilers.

These results were obtained over a period of ten years and represent all types of boiler and furnace equipment collectively. However, they should not be taken as representing the best that can be obtained in each individual class, but merely as averages that were found when operating under normal, every-day conditions, with a combustion engineer present analyzing gases, studying conditions, and establishing standards at which the equipment was subsequently operated as being most efficient.

The lower curve shows the rate of heat absorption by the boiler and superheater per cubic foot of furnace volume, this being merely indicative of the different types and methods of burning. It is to be noted that the number of tests in the lower line is less than that on the upper, which is due to the fact that complete data as to furnace volume were not available in all cases.

Fig. 2 represents the same data, but with reference to the limitations which prevented the further reduction of excess air.

It is to be noted that CO predominates as the limiting factor in all cases where coal is burned in fuel beds and also in the gas-fired boilers, while smoke is the guide in determining the minimum excess air for oil.

Ashpit loss comes in as a fairly important factor as regards the

[1] President, Bailey Meter Company. Mem. A.S.M.E.

Presented at a meeting of the Metropolitan Section of the A.S.M.E., New York, April 8, 1926.

mechanical stoker, and in the more modern types of stokers the refractories obtain more attention than in the earlier types where higher excess air prevailed.

Pulverized coal has been limited in excess-air reduction almost entirely by refractories. In other words, the furnace-temperature control is a matter of prime importance due to the large area of walls and the fact that the ash is carried in suspension and deposits on the walls, thus diminishing the resistance of the latter to slagging and erosion.

Relation Between Percentage of Excess Air and Rate of Combustion

It would hardly be proper to give only the averages of the different groups and types of equipment without showing what results have been accomplished in some of the individual installations of the later and more modern types. Therefore, in Fig. 3 are shown plots of several of the more modern plants giving the relationship between percentage of excess air and the rate of combustion. For this purpose the number of B.t.u. absorbed by boiler and superheater per cubic foot of furnace volume per hour has been adopted as a basis for comparison. It is realized that this is not the figure generally given, because usually the number of B.t.u. developed per

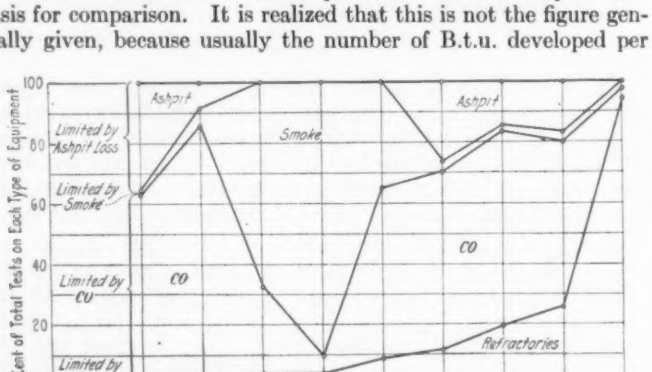


Fig. 2 Relative Frequency of Occurrence of the Various Limiting Factors at Normal Ratings on Different Types of Fuel-Burning Equipment

cubic foot is determined from the coal fired. However, in work of this kind it is not always possible to determine the weight of coal burned, but it is a comparatively simple matter to determine the rate of B.t.u. output as shown by the flow meter, and this is always available in connection with the work represented herein.

From another standpoint the number of B.t.u. absorbed is better than the number put into the furnace, because all of the heat is not necessarily developed into usable form, as in the case of high loss due to unburned gas and unburned fuel in the form of carbon.

The limiting factors such as CO, smoke, refractories, etc., are designated by different types of lines in plotting the curves of the various plants, and it is to be noted that many of the lines show a varying excess air at different ratings. This is where a careful study had been made to adjust the meters so that the steam flow and air flow will be together at all ratings when exactly the right amount of air is furnished for most economical operation.

Where known, the fusing temperature of the ash in the coal being burned is given in the tabulation. It is seen that coal having ash of a lower fusing temperature requires higher excess air or else limits the operation to lower ratings in B.t.u. per cu. ft.

It is to be noted that when refractories are the limiting factor for either pulverized coal or stokers as in P1, P2, P3, P4, and C1, the percentage of excess air increases with the rating. The cooling effect of the increased amount of excess air offsets the tendency for the furnace temperature to increase with the rating, and results in maintaining a substantially uniform temperature in the furnace, which prevents heating the walls beyond the fusing temperature of the ash.

It will be seen from the curves O1 for oil and P6 for pulverized coal, where water cooling has solved the refractory trouble, that smoke is the limiting factor and that the percentage of excess air decreases with increased rating; or, to state this inversely, when the temperature of the furnace is decreased, the percentage of excess air must be increased to offset the lowering of temperature in order to get anything like complete combustion.

The underfeed stokers are plotted with CO as the limiting factor in most cases, although it may be that unburned coal and refractories should be given a little more consideration than they have been.

Curves U5 and O2 are taken from the same boiler and furnace adapted to burn coal or oil. In this as in some of the other smaller furnaces of older design and a high rate of B.t.u. per cubic foot, the refractory trouble is minimized because of the radiant-heat-absorbing capacity of the front row of boiler tubes.

Values for oil are much higher with small furnaces and mechanical burners, even reaching 85,000 B.t.u. absorbed per cubic foot of furnace volume in some cases. In most cases smoke is given as the limiting factor in reducing excess air in oil-fired furnaces, although sometimes the life of the refractories is comparatively short and it is a question as to whether the excess air might not be increased to advantage from the standpoint of total cost.

It is of course obvious that what we are all striving to attain is the minimum excess air and the highest rating for a given furnace volume, which means lower installation cost for the furnace equipment. It would seem from the data given in Fig. 2 that oil as a fuel holds the leading position in this respect. In many ways oil is ideal in that it does not contain any great percentage of ash; therefore the fluxing of the walls is not an important factor, high temperatures can be obtained, and with good atomization the excess air can be held very low.

In many respects gas is a better fuel to handle than oil, but due to its bulk and the trouble of thorough mixing, it usually requires a larger furnace volume, and as shown by both the individual and average results, it is usually burned at a lower rating than oil.

Pulverized coal, the third of the fuels being burned in suspension, is operated with a higher average excess air and a lower rate of B.t.u. absorption per cubic foot of furnace volume. This difference, in comparison with oil, is largely due to the trouble caused by the fluxing of refractory by the ash in the coal, and also due to the fact that it is not atomized as finely as is oil from a good burner, even though it is pulverized to 200 mesh. It is therefore evident that the larger particles require a larger furnace and longer period of time for best results.

With fuels burned on underfeed and chain-grate stokers the average results indicate higher excess air, with rates of combustion approaching those of oil, yet individual installations of modern equipment show lower excess air where water-cooled furnace construction has solved the refractory problem satisfactorily, or where coal having a higher-fusing-temperature ash is used.

It is believed that Fig. 3 will enable different plant operators to study their own performance and see how it plots up with the same type of equipment, and perhaps this basis of comparison will assist operators and manufacturers of different power-plant equipment in their endeavor to reach the goal we are all striving so hard to attain.

There is another point of comparison that is not brought out with definite numerical values in Figs. 2 and 3, namely, the relative importance of the limiting factor where it relates to CO and unburned fuel.

Relation Between Excess Air and CO Loss

Fig. 4 represents the relation between excess air and CO loss and applies fairly well to either underfeed or forced-draft chain-grate stokers. Curve A represents theoretical conditions with perfect mixture and a reduction in excess air until the theoretical amount is reached. Any further reduction will of course result in unburned gas, usually in the form of CO—and perhaps some hydrocarbons also, thereby increasing the rate of heat loss approximately 15 times as fast for each per cent of deficiency in air as it does for each per cent of excess air.

Since a perfect mixture cannot be obtained, the curves for different furnaces designated as B, C, and D show the points at which CO begins to appear, and the rate of its increase with decreasing percentages of excess air.

The lower set of curves showing the total losses due to excess air,

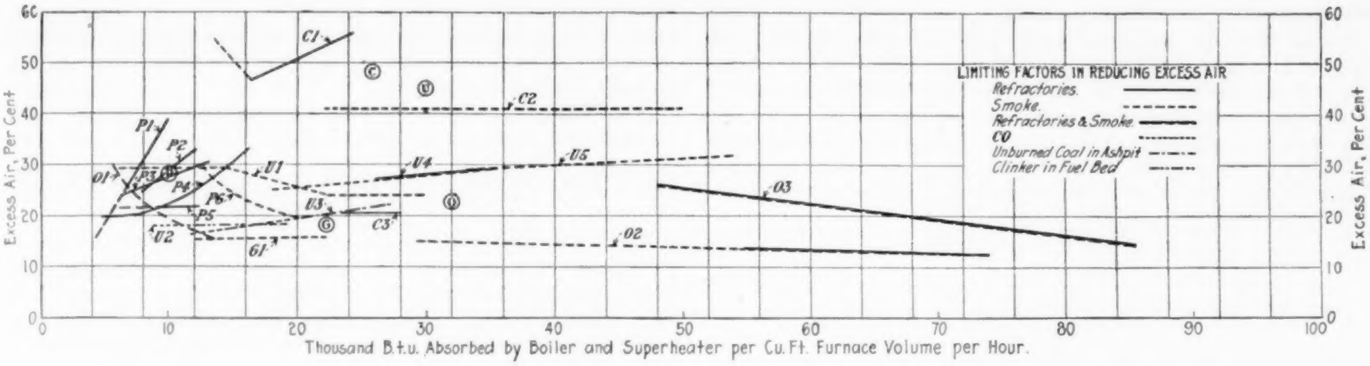


FIG. 3 RELATION BETWEEN PERCENTAGE OF EXCESS AIR AND RATE OF COMBUSTION IN A NUMBER OF MODERN PLANTS

Plant	Fuel-Burning Equipment	Kind of Fuel	Fusing Temperature of Ash, Deg. Fahr.	Area of Boiler Surface, Sq. Ft.	Furnace Volume, Cu. Ft.	Furnace Details
P1	Pulverized coal	Bituminous	2000	30,000	26,000	Hollow walls; water screen
P2	Pulverized coal	Bituminous	2000	18,000	12,500	Hollow walls; water screen bottom and back wall
P3	Pulverized coal	Bituminous	2200	5,000	4,200	Solid walls, front, sides and floor; air-cooled back wall
P4	Pulverized coal	Bituminous	2050	14,000	11,100	Hollow walls; water screen
P5	Pulverized coal	Bituminous	2350	17,700	12,000	Hollow side and front walls; water screen in bottom and superheater in back wall
P6	Pulverized coal	Bituminous	2000	5,600	3,150	Water-cooled walls
(P)	Pulverized coal	Average of all tests in all plants				
U1	Underfeed stoker	Bituminous	2320	18,800	5,318	Brick walls, with some air-cooled blocks
U2	Underfeed stoker	Bituminous	2500	19,600	7,500	Brick walls, with some air-cooled blocks
U3	Underfeed stoker	Bituminous	2500	15,700	7,780	Water-cooled walls
U4	Underfeed stoker	Bituminous	?	11,400	3,710	Brick walls, with some air-cooled blocks
U5	Underfeed stoker	Bituminous	?	6,000	700	Solid brick walls
(U)	Underfeed stoker	Average of all tests in all plants				
C1	Forced-draft chain grate	Bituminous	1900	16,600	6,000	Front arch; water boxes rear and sides at fuel bed
C2	Forced-draft chain grate	Anthracite	2600	19,600	4,100	Front and rear suspended arches
C3	Forced-draft chain grate	Bituminous	2000	14,100	5,000	Front arch; water boxes rear and sides at fuel bed
(C)	Forced-draft chain grate	Average of all tests in all plants				
G1	Multiple-jet burners	Natural gas	....	7,000	1,860	Solid brick walls
(G)	All kinds of gas burners	Gas of various kinds, average of all tests in all plants				
O1	Mechanical oil burners	Crude oil	....	14,920	13,000	Hollow walls and some water-cooling tubes in floor
O2	Mechanical oil burners	Oil	....	6,000	700	Brick walls; no water cooling
O3	Mechanical oil burners	Oil	....	5,200	725	Brick walls; no water cooling
(O)	Mechanical oil burners	Average of all tests in all plants				

unburned gas, and latent heat indicate the most efficient percentage of excess air to be striven for. For furnace B the most efficient point is with about 12 per cent excess air; for furnace C it is 30 per cent excess air, while with furnace D 70 per cent excess air is the most efficient point; that is, provided no other factors except CO and excess air are considered.

The question of unburned coal over the end of chain-grate stokers often holds a close relation to excess air, and this should be studied separately.[2]

Carbon loss should also be carefully checked on other types of stokers, as well as on pulverized coal, where the carbon is likely to escape in the flue dust and may sometimes reach serious proportions even without showing objectionable black smoke.

Whenever smoke of any consequence does appear in gases from pulverized coal, it is indicative of a considerably greater loss than when smoke results from the combustion of other types of fuel.

THEORETICAL TEMPERATURES OF COMBUSTION WITH DIFFERENT PERCENTAGES OF EXCESS AIR

In discussing Fig. 3 it was pointed out that under certain conditions it was necessary to increase the percentage of excess air with rating in order to minimize difficulties and expenses in connection with refractory. The need for this is brought out in Fig. 5, showing the theoretical temperature of combustion with different percentages of excess air. It is noted that there is an increase in theoretical temperature of about 200 deg. for each 10 per cent reduction in excess air. Therefore the percentage of excess air is a very important factor in controlling furnace temperatures for a given set of furnace conditions.

This point is of course well known and carefully followed in metallurgical work, where temperatures receive first consideration. High furnace temperatures are also of great importance in connection with the efficient combustion of fuel, and are quite analogous to the greater efficiency obtained from higher steam pressures and higher voltages in the transmission of energy in the form of steam and electricity. Heat is transmitted from the furnace to the heating surface more efficiently with higher furnace temperatures than it is with low heat potentials.

[2] Reference is here made to the author's previous paper, Recording Ashpit Loss from Chain-Grate Stokers, Trans. A.S.M.E., vol. 43 (1921), p. 19.

Fig. 5 also repeats the curve showing the loss in sensible heat from flue gases with different percentages of excess air and unburned gas, and it also shows the reduction in furnace temperature when a deficiency below the theoretical amount of air exists.

It is seen that an increase in flue-gas temperature occurs with an increase in percentage of excess air. This is true, and is due to the

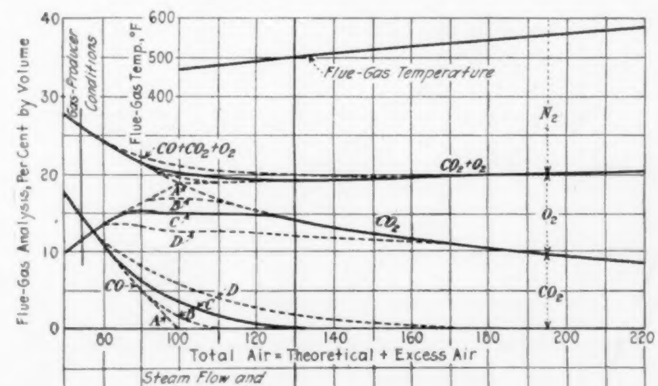


FIG. 4 COMBUSTION DIAGRAM FOR FUEL BURNED ON STOKER

[McDowell Co., W. Va., coal. Proximate analysis: Moisture, 2.19; volatile, 13.91; fixed carbon, 75.25; ash, 8.65. Ultimate analysis: S, 0.57; H, 4.45; C, 80.69; N, 1.19; O, 4.45; B.t.u., 13,995 (lower, 13,607).]

higher velocity of the gases through the boiler and the lower rate of heat transfer by radiation when the initial temperatures are lower. This curve is taken from actual data, while the other curves of the figure are theoretical. The two upper curves show air for combustion coming into the furnace at 70 deg. as well as at 500 deg. preheat. Preheated air is an important factor today as it is so widely used in our modern furnaces.

Fig. 6 shows the theoretical temperature when burning a repre-

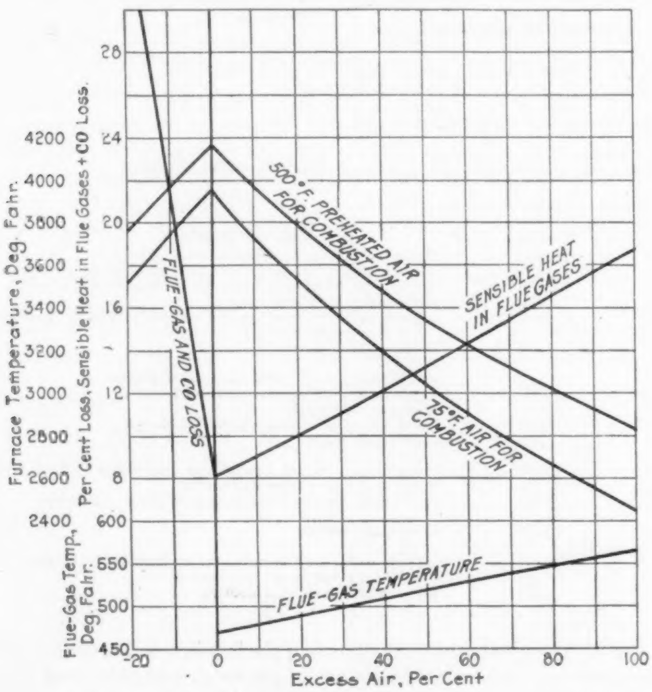


FIG. 5 THEORETICAL TEMPERATURES OF COMBUSTION OF COAL
(For analysis of coal, see sub-caption of Fig. 4.)

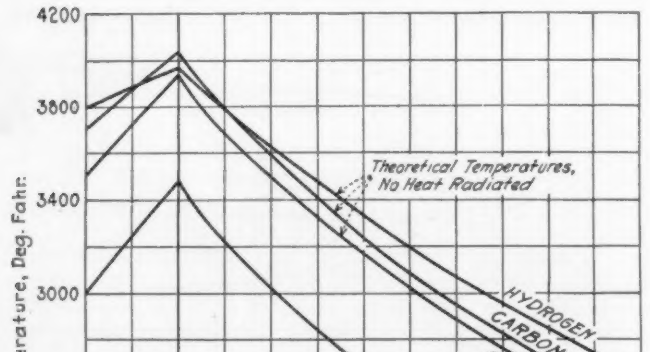


FIG. 6 TEMPERATURES OF COMBUSTION OF HYDROGEN, CARBON, AND COAL

sentative coal as well as when burning carbon and hydrogen. This comparison is made merely to show the different types of fuel and the effects of the varying specific heats of the products of combustion resulting from burning fuels of different types.

The curve for coal is lower than either the carbon or hydrogen curve because of the moisture and ash that it contains, and which must be heated to the furnace temperature as combustion takes place.

The lower curve shows the theoretical temperatures when 25 per cent of the heat developed is absorbed by direct radiation to the boiler heating surface. This subject has recently been discussed in papers recently presented to the Society by Messrs. Wohlenberg and Morrow,[3] and Broido.[4]

With different amounts of radiant-heat-absorbing surface, other theoretical furnace temperatures would result.

RELATIONS BETWEEN RATE OF COMBUSTION, EXCESS AIR, AND FURNACE TEMPERATURE

Fig. 7 is a three-dimensional diagram showing the relations between rate of combustion, excess air, and furnace temperature. The rate-of-combustion curve is taken from Fig. 1, curve *A*, of Wohlenberg's paper, which compares closely with the furnace represented as P1 in Fig. 3. The diagram is drawn with isothermal lines at 2000, 2300, 2500, and 3000 deg. fahr., showing the necessity of increasing excess air with rate of combustion if a uniform furnace temperature is to be maintained.

It must be remembered that the warped surface in this figure represents a given boiler condition, while if a greater amount

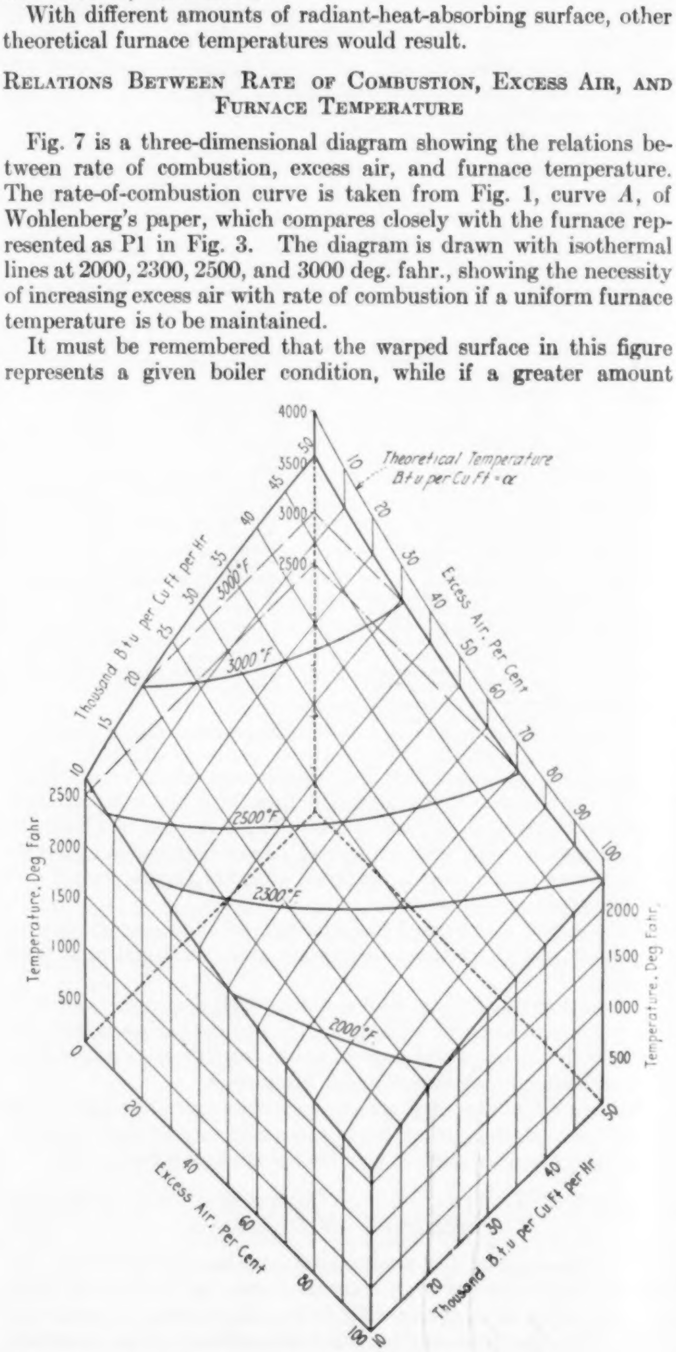


FIG. 7 DIAGRAM SHOWING RELATION BETWEEN RATE OF COMBUSTION, EXCESS AIR, AND FURNACE TEMPERATURE

of radiant-heat-absorbing surface or wall cooling surface were installed, then the warped surface would be of a similar nature but at a different elevation with respect to the temperature value.

The importance of excess air in controlling furnace efficiency and operating conditions has been pretty well brought out in the foregoing data and references. The next question is, What is the best method to determine the percentage of excess air both for test and investigation work, as well as for the daily operating guide of the fireman?

It is rather lamentable that so many people consider CO_2 and ex-

[3] Radiation in the Pulverized-Fuel Furnace, MECHANICAL ENGINEERING, August, 1925, p. 627.

[4] Radiation in Boiler Furnaces, MECHANICAL ENGINEERING, February, 1926, p. 133.

cess air as synonymous, and it is safe to say that the majority today refer to combustion conditions by stating the percentage of CO_2 obtained rather than by referring to the percentage of excess air. Most people have stopped with this one figure, oftentimes feeling that it represented the whole story of combustion efficiency. The author would like to emphasize that this is not the case, for the percentage of CO_2 desired with any given fuel depends upon the chemical composition as shown in Fig. 8, ranging from $7^1/_2$ per cent with coke-oven gas to 22.8 per cent CO_2 with blast-furnace gas for 20 per cent excess air. Even with different kinds of coal the CO_2 varies more than 1 per cent for the same excess air. It is becoming more and more common to change back and forth from one kind of fuel to another, such as coal, oil, or gas, and oftentimes to burn a mixture of gas and pulverized coal or other fuels in the same furnace simultaneously. It is therefore quite important to analyze the flue gas for more than CO_2 to determine the percentage of excess air accurately.

For all fuels except blast-furnace gas the following formula is substantially correct for figuring the percentage of excess air:

$$\text{Excess Air} = 100 \times \frac{O_2}{0.264N_2 - O_2}$$

From Fig. 9 it will be noted that the percentage of oxygen is a

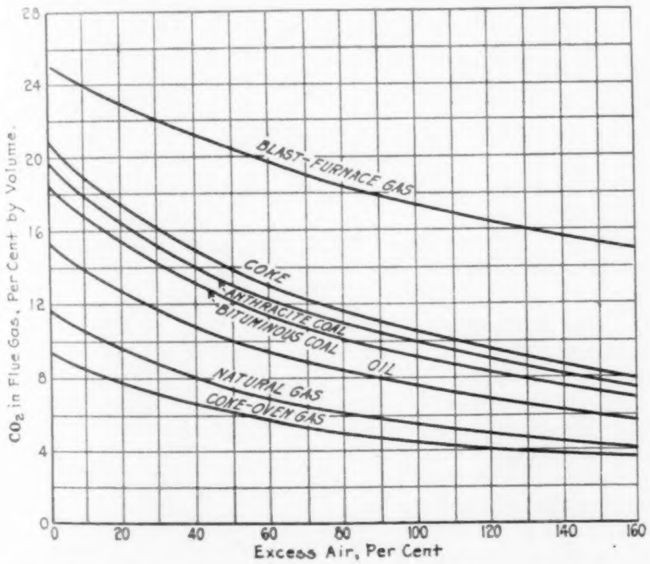


FIG. 8 RELATION BETWEEN CO_2 IN FLUE GAS AND EXCESS AIR FOR VARIOUS FUELS

much closer indication of excess air than is the percentage of CO_2, but even oxygen as a guide varies with different fuels depending upon the hydrogen-carbon ratio, so that it alone is not a true indication of excess air.

RELATION BETWEEN EXCESS AIR AND $CO_2 + O_2$ IN DIFFERENT FUELS

Fig. 10 brings out the relation between excess air and the total of CO_2 and oxygen in different fuels.

In a carbon fuel having no available hydrogen the CO_2 plus oxygen is equal to 20.9 per cent when there is no CO present. However, in fuels which have available hydrogen there is a certain amount of oxygen which combines with the hydrogen, forming water vapor, and thereby disappears from the gas analysis as ordinarily made. This shrinkage increases, so to speak, with the percentage of available hydrogen in the fuel, so that with oil, natural gas, and coke-oven gas the total CO_2 and oxygen is considerably below the figures with which we are familiar in analyzing flue gases from bituminous coal.

It is best for one to be on his guard in checking over gas analyses from various kinds of fuel to make sure that the samples are representative and the analyses are being properly made. While the curves given here are labeled "Oil," "Natural Gas," "Bituminous Coal," etc., they are not to be taken as truly representative of all such fuels, because any particular fuel of a given class having a different ultimate analysis, or rather a different ratio of available hydrogen to carbon, will give different results on this gas-analysis basis.

For example, in the burning of a coal having 79.86 per cent carbon and 4.04 per cent available hydrogen, the available hydrogen-carbon ratio is 0.0506 per cent. If a flue-gas analysis from this

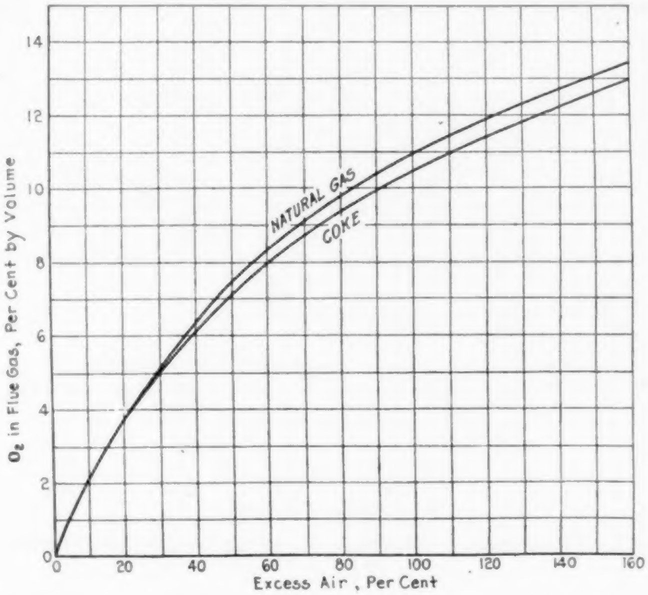
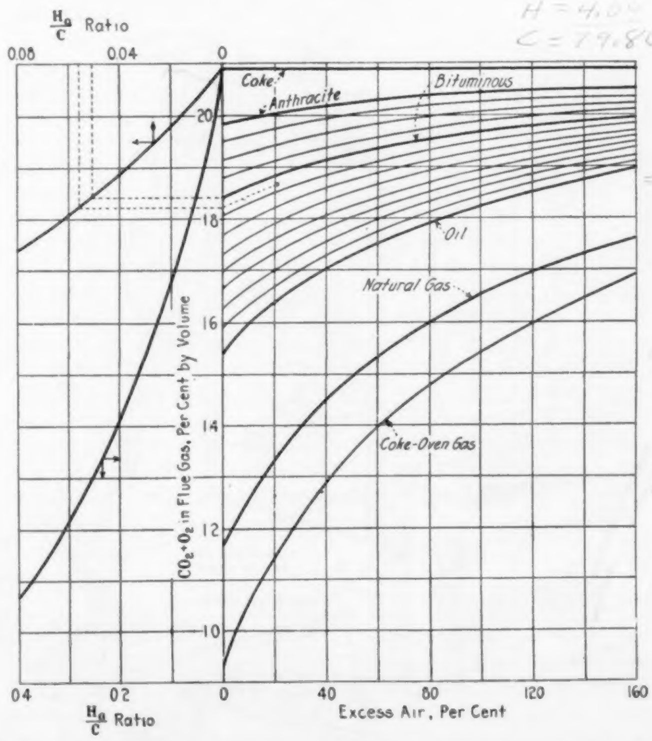


FIG. 9 RELATION BETWEEN OXYGEN IN FLUE GAS AND EXCESS AIR FOR NATURAL GAS AND COKE



H = 4.04
C = 79.86 = .0506
4.04
.0560
= 72.14
15.16
3.71
18.87
14.96
3.72
18.68

FIG. 10 RELATION BETWEEN $CO_2 + O_2$ IN FLUE GAS AND EXCESS AIR FOR VARIOUS FUELS

shows 15.16 per cent CO_2, 3.71 per cent oxygen, and 81.13 per cent nitrogen, then the percentage of excess air is 21, and from Fig. 10 it is found that this checks exactly on the curve marked "Bituminous Coal," and, following over, checks on the available hydrogen-carbon ratio of 0.0506 per cent.

Supposing, however, that a gas analysis from this same coal showed 14.96 per cent CO_2, 3.72 per cent oxygen, and 81.32 per cent nitrogen; the excess air would figure the same, namely, 21 per cent, but following this through from the curve would show a ratio of avail-

able hydrogen to carbon of 0.0560. If we assume that all of the hydrogen in the fuel was burned, which is very likely to be true, then dividing the percentage of available hydrogen, 4.04, by the 0.0560, gives 72.14 as the percentage of carbon in the fuel that was actually burned and which was shown up in the gases as CO_2. This would indicate that 7.72 of the 79.86 per cent carbon in the fuel was lost in the form of coke going to the ashpit, or as solid particles

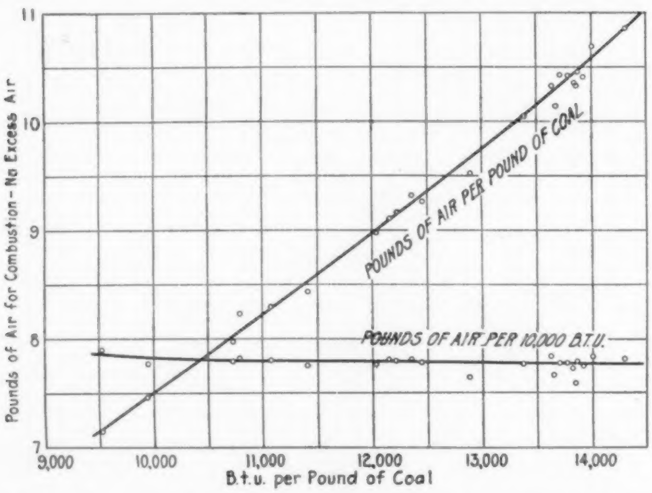


Fig. 11 Theoretical Air Requirements in the Combustion of Different Coals

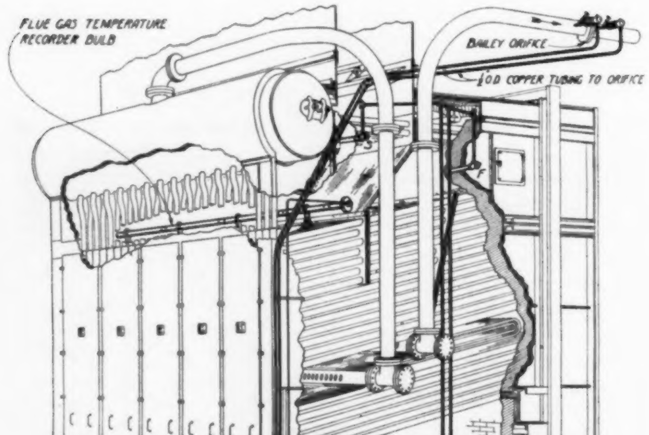


Fig. 12 Arrangement of Apparatus for Carrying Out Measurements of Steam Flow and Air Flow in a Typical Boiler Installation

of carbon escaping in the flue gases. It is obvious that with the burning of pulverized coal and the desire to determine the carbon loss more accurately, careful flue-gas analyses must be made in order to aid in detecting this carbon loss without the necessity of running complete boiler tests and thus determining it through the medium of unaccounted-for loss in the heat balance. It is true that this will require more accurate gas analyses than we are accustomed to obtain with the Orsat apparatus. However, it is evidently worth while and should be given careful consideration.

Another point to be given careful consideration in this study of gas analyses is that of stratification of the gases. Gas samples taken from a stratum in which an abnormally large percentage of the hydrogen is being burned will give a lower total $CO_2 + O_2$ than is normal for the fuel. The extreme case may approach that of coke-oven gas. On the other hand, if the sample is taken from the rear end of a chain-grate stoker, the total $CO_2 + O_2$ will run very high, approximating that of coke. It is obvious from Fig. 10 that when bituminous coal is divided into its two components, namely, coke and gas, the resulting flue gas gives almost 10 per cent difference in the $CO_2 + O_2$ value for 20 per cent excess air.

A Method of Determining Excess Air Continuously and Instantly

As stated in the early part of the paper, the data given in Figs. 1, 2, and 3 were obtained from combustion studies made in connec-

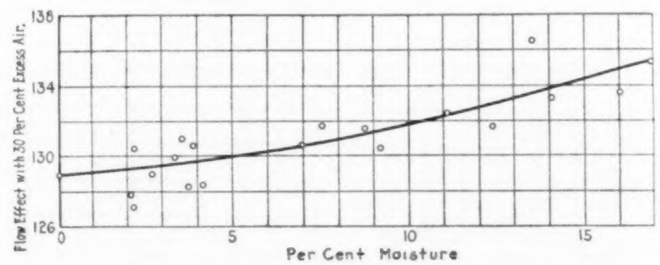


Fig. 13 Flow Effect of Products of Combustion from Various Coals

$$\text{Flow Effect} = \frac{21{,}600 \times \text{wt. of gases per lb. fuel} \times \sqrt{\text{sp. vol. at 800 deg. fahr.}}}{\text{Lower heating value}}$$

(Constant 21,600 chosen to give flow effect of 100 when burning carbon with no excess air.)

tion with the work of determining the best steam flow-air flow relation of the Bailey Boiler Meter, which relation is founded upon actually measuring the quantity of products of combustion passing from a boiler furnace and comparing it with the steam produced from the combustion of the fuel producing these gases. This has proved a very valuable means of determining excess air continuously and instantly in all types of furnaces as fired with various kinds of fuel.

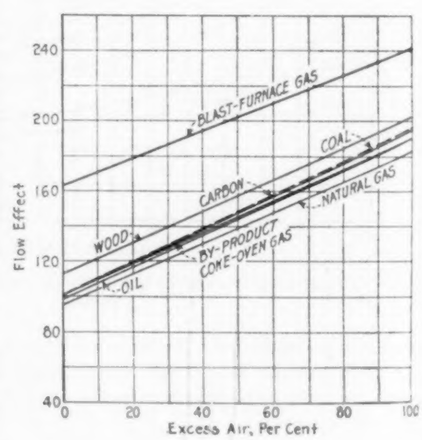


Fig. 14 Flow Effect of Products of Combustion

(For value of flow effect see sub-caption of Fig. 13.)

The principle is fundamentally sound as is shown by Fig. 11, where the weight of air required for combustion of various kinds of coal is plotted against the heating value of various coals throughout the United States as taken from the Bureau of Mines Reports. It will be noted that when replotted in pounds of air per 10,000 B.t.u., substantially 7.80 lb. of air are required per 10,000 B.t.u., regardless of the kind of coal burned.

The measurement of the steam flow and air flow is carried out on a typical boiler substantially as shown in Fig. 12. The second and third passes of the boiler are taken as an orifice and the differential pressure across these passes as taken between points F and S varies in a known way with the quantity of gases flowing through, thus becoming a measure of the quantity of air used for combustion. This measurement is at the point closest to where the temperature of the escaping gases is of greatest significance. The heat produced from the combustion of fuel is measured by the steam output from the boiler, which serves as a calorimeter absorbing a given percentage

of the heat provided combustion efficiency is properly maintained and the correct percentage of excess air is used.

Examining a little closer the theoretical accuracy of this method of measuring excess air, it is seen, in reality, that it is the "flow effect" of the volume of gases that must be considered. As shown in Fig. 13, this is substantially constant for all different kinds of coal, varying slightly with the percentage of moisture, which causes the greatest error in this result as the moisture is an inert, foreign vapor or gas, producing a record on the air flow but not effective in generating steam. It is seen that the greatest deviation is 4 per cent from the standard with a variation in moisture of 15 per cent.

In Fig. 14 a comparison is made of the flow effect of the products of combustion from different fuels with different percentages of excess air. As a rule, when only one class of fuel is being burned the meter is set by empirical adjustment to read correctly for that given class of fuel. Where a periodic change is made from one kind of fuel to another and radically different kind, the meter can be reset to read correctly with whichever fuel is being burned.

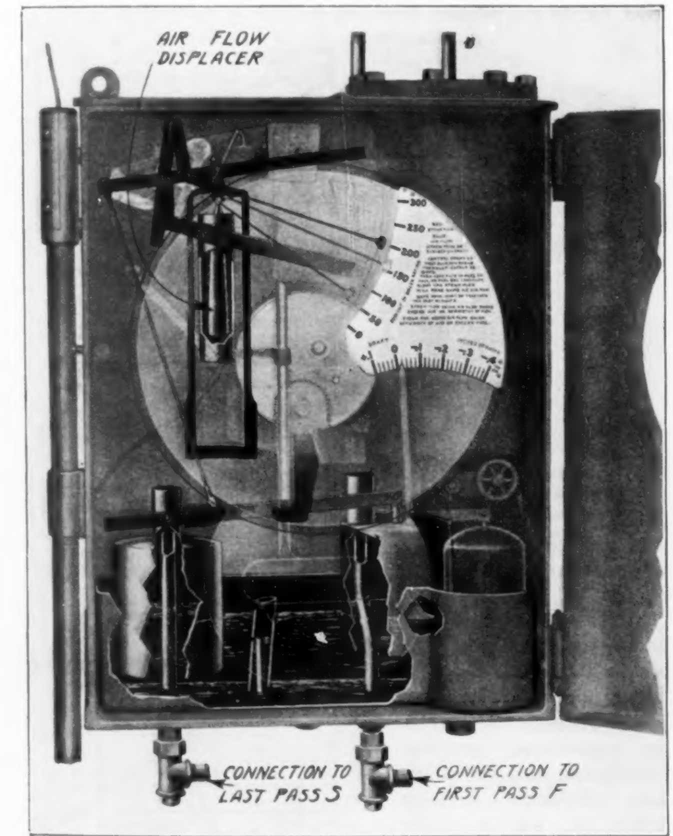


FIG. 15 THE AIR-FLOW MECHANISM OF THE BAILEY BOILER METER

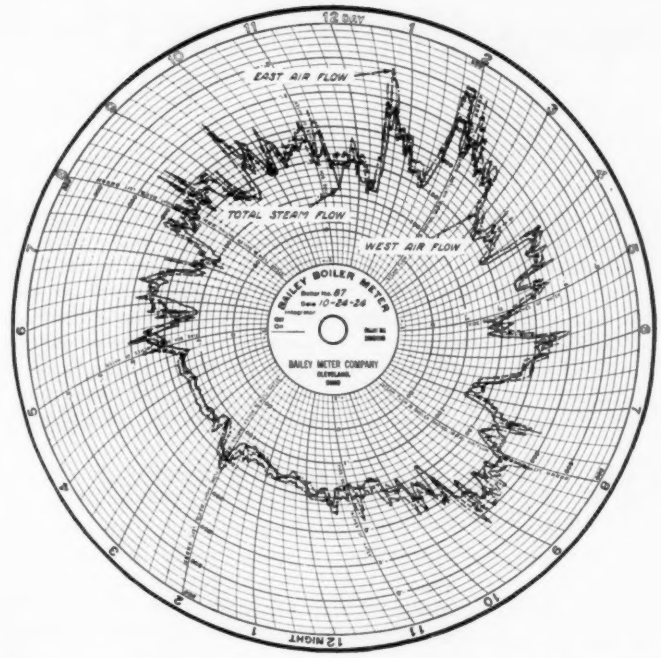


FIG. 16 CHART RECORD TAKEN FROM A BOILER METER ON A PULVERIZED-COAL-FIRED BOILER OPERATING WITH A VARIABLE EXCESS AIR AS SHOWN IN FURNACE P1 OF FIG. 3

From recent developments it has been found possible to modify the construction of the meter so that when burning a mixture of two different classes of fuels, such as pulverized coal and blast-furnace gas, the meter can be adjusted to read correctly, regardless of the proportion of the two being burned. This modification also provides for burning the different fuels with different percentages of excess air.

A varying excess air for different ratings is also readily taken care of by the shape of the displacer in the air-flow mechanism as shown in Fig. 15. The two connections *S* and *F* at the bottom of the recorder casing are connected to the uptake and the top of the first pass, respectively, so as to cause the differential pressure to become effective on the two bells the same as in a flow meter. The differential pressure produces a force which lifts the displacer out of the mercury, and the shape of this displacer as well as its adjustable moment arm govern the travel of the air-flow pen or indicating means with respect to the actual quantity of gases flowing through the boiler. It is obvious that this pen can be coördinated with the steam-flow pen by the proper initial adjustment of the displacer location, so that the two records will remain together as long as the correct percentage of excess is being obtained at different ratings. Fig. 16 shows a chart record taken from a boiler meter on a pulverized-coal-fired boiler operating with a variable excess air as shown in furnace P1 of Fig. 3.

Machinability of Alloy Steels

FACTORS Affecting the Machinability of Alloy Steels was the title of a paper by J. S. Vanick and T. H. Wickenden before the Spring Sectional Meeting of the American Society for Steel Treating. It was a report of an extensive investigation on this subject, having to do principally with the smooth finish machining of low-carbon, plain, and alloy steels. Machining tests were made upon such steels suitable for carburizing to determine the requirements for obtaining smooth surfaces. In order that the finishing cuts might be correlated with the vast amount of data available upon roughing cuts and breakdown tests of tools, a $^1/_4$-in.-wide round-nose tool shaped to the 14-deg. side-slope, 8-deg. back-slope, 6-deg. clearance angles recommended in Taylor's original work, was used for a series of cuts ranging from 0.015 in. to 0.090 in. in depth and 0.015 to 0.060 in. in feed.

The circular-disk method of varying the speed was used by starting the tool on its cut at the periphery of a 10-in.-diameter disk moving at a fixed r.p.m. and thereby obtaining a speed variation from surface to center of the face. By this method the finish on the disk would change from a smooth to a rough finish at certain critical speeds, the change being complete with a cutting-speed change of 10 to 15 ft. per min. In general, at a still lower speed, the finish would again change from rough to smooth.

A practical indication of the proper speed for a good high-speed finish occurred in the appearance of a hot temper-colored chip. The speeds required to obtain a good finish are considerably lower than the breakdown speeds derived from Taylor's work, with fine feeds and depths, on medium-hard steel. Fine speeds left better surfaces than coarse speeds, and where the removal of metal was important, deep cuts with fine feeds would be preferred to shallow cuts with coarse feeds.—*The Iron Age*, May 27, 1925, p. 1647.

Speed Changes of Hydraulic Turbines for Sudden Changes of Load

By EARL B. STROWGER,[1] NIAGARA FALLS, N. Y., and S. LOGAN KERR,[2] PHILADELPHIA, PA.

This paper shows how the variation in speed of hydraulic turbines due to sudden load changes may be determined by the application of the fundamental principles of water hammer with allowances for variation of turbine efficiency. The methods of determining governor time are noted. The relation of generator flywheel effect to speed variation is established and methods are indicated for the proper selection of these characteristics. Numerical examples are shown illustrating the speed changes for various load changes on a 70,000-hp. hydroelectric unit. The application to practical cases and the accuracy of approximate formulas are discussed.

THE ability of a hydraulic-turbine governor to regulate the speed of the unit satisfactorily depends upon three fundamental considerations:

1 Mechanical correctness
2 Proper field adjustment
3 Complete coördination of the governor characteristics with the physical constants of the installation.

The first two will not be discussed although they play a very vital part in securing good speed regulation. The third consideration is most important of all. In advance of the actual construction of a hydroelectric project, it is often desirable to know the amount of speed change occurring at various times following a load change, in order to make adjustment of the electrical protective devices, or to determine the possibility of overvoltage conditions in the stator of the generator or on transmission systems[3] due to sudden load changes.

This paper discusses the methods of predetermining such speed changes, and indicates the methods to be employed in selecting the proper generator flywheel effect and the correct time of governor movement. It is based on the application to the problems of speed regulation of the theory of rise and fall in pressure due to velocity changes in the penstock.[4]

Physical Constants of Installation

With the physical constants of the installation, comprising the head, the capacity of the units, the length of and velocities in the conduit, fixed by local considerations, the speed regulation obtained becomes a question of compromise between the time of governor action, the allowable pressure variation in the penstock, the flywheel effect of the generator and turbine, and the permissible speed variation for given load changes on the unit. The governor time may be determined independently by fixing the maximum allowable rise or fall in pressure in the penstock. The two variables remaining, comprising the flywheel effect of the rotating element and the speed variations for given load changes on the unit, may then be found.

Determination of Governor Traversing Time

With the length, diameter, and profile of the penstock determined, considering, in the case of high heads and long water conduits, that a properly designed surge tank or open forebay constitutes a point of relief, the minimum time of closure of the turbine gates depends upon the maximum rise in pressure allowable for the strength of the penstock or upon the maximum fall in pressure permissible to avoid the formation of a vacuum due to acceleration. It is usual to design hydroelectric plants with the maximum rise in pressure not in excess of 50 per cent of the normal head on the turbine, but it is frequently found desirable to limit this rise to 25 per cent or less, in order to avoid excessive stresses in the penstock and the danger of rupture following water-hammer surges.

In certain installations the rise in pressure is taken care of by providing an auxiliary relief valve opened by the governor as the gates are closed, thus bypassing the water and reducing the rate of change in velocity to a minimum. In calculating the speed rise for such cases the quantity of water discharged by the relief valves is deducted from the total flow in computing the rise in pressure and change in velocity.

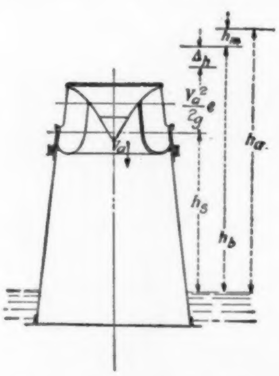


Fig. 1 Calculation of Draft-Tube Surge
h_a = atmospheric pressure
h_m = vapor pressure
h_b = barometric-limit water column

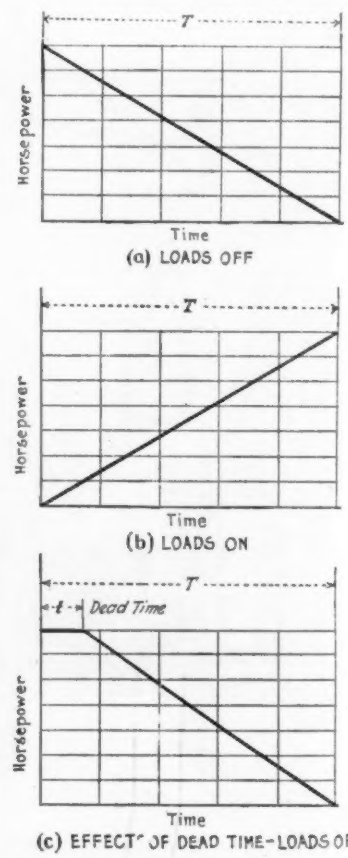


Fig. 2 Uniform Variation of Horsepower with Respect to Time

In the case of oncoming loads, the profile of the penstock should be considered and the maximum fall in pressure calculated, the acceleration gradient determined, and the minimum allowable opening stroke of the governor established in this manner.

In determining the flow through the conduit the rated capacity of the units should be taken and the discharge corresponding to this output at an efficiency of 85 to 88 per cent calculated. Although the actual efficiency may be greater than this, the use of the lower efficiency will compensate for any load capacity.

Governor traversing time is taken as the time required for the governor to move the gates from the rated-capacity position to the speed no-load position, including an allowance for the dead time of the governor, which is the period that elapses between the rejection or application of load and the first movement of the turbine gates. This time is usually less than half a second for modern governors.

Fig. 4 illustrates the proportions of full-gate time required for intermediate-gate strokes. The rated capacity will occur at some gate opening less than full as there is always a margin allowed in power. The amount of gate opening required for a given increment of power is much greater beyond the point of the maximum efficiency than below this value. This tendency grows more pro-

[1] The Niagara Falls Power Company.

[2] Assistant Hydraulic Engineer, Wm. Cramp & Sons Ship & Engine Building Co. Jun. A.S.M.E.

[3] See Overvoltage on Transmission Systems Due to Drop of Load, by E. J. Burnham, Jl. A.I.E.E., May, 1925.

[4] See Pressure in Penstocks Caused by Gradual Closing of Turbine Gates, by N. R. Gibson, Trans. A.S.C.E., vol. lxxxiii (1920), p. 707.

Fall in Pressure in Hydraulic Turbine Penstocks Due to Acceleration of Flow, by S. Logan Kerr, in Hydraulic Power Committee Report (1924), National Electric Light Association.

Presented at the Spring Meeting, San Francisco, Cal., June 28 to July 1, 1926, of The American Society of Mechanical Engineers. Abridged.

nounced as the specific speed increases, hence the assumption regarding governor time as noted above is specified.

Fig. 3 illustrates, for a unit having a specific speed of 34.7 in the foot-pound system, a curve of percentage of gate opening plotted against percentage of rated capacity.

In the case of installations involving a length of penstock which would permit a governor time of less than two or three seconds, if the governor stroke is made too rapid, the water column below the runner may break due to excessive vacuum followed by a dangerous return surge.

In a closed conduit it is assumed that the deceleration of flow produces the same effect whether it is accomplished by means of a valve at the lower end of the conduit causing a rise in pressure above normal at this point, or by means of a valve at the upper

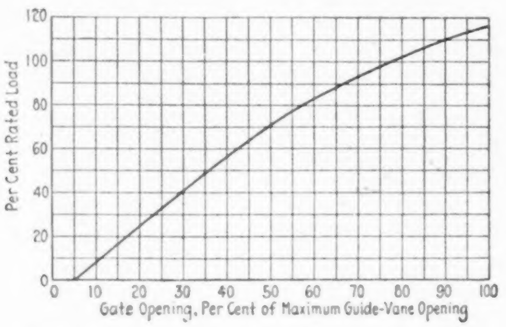


FIG. 3 RELATION BETWEEN GATE OPENING AND RATED CAPACITY, SPECIFIC SPEED 34.7

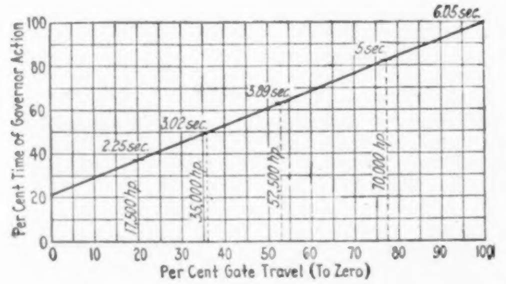


FIG. 4 PROPORTIONS OF FULL-GATE TIME FOR INTERMEDIATE-GATE STROKES

end of the conduit with an equal fall in pressure. In the case of the draft tube the discharge is completely sealed against admission of air, and the inertia of the column is calculable by the application of the water-hammer theory.

It is possible to calculate the average velocity of the water passages in the draft tube, and, since the length is known, the rise in pressure due to a given governor time may be calculated. This rise in pressure will be manifested as an increase in vacuum, and the sum of this increase plus the absolute velocity head regained in the top of the draft tube at the discharge from the runner and the elevation in feet of this point above tailwater should not exceed the barometric limit.

$$\Delta h = h_b - \frac{V_a^2}{2g} e - h_s$$

Δh = allowable increase in vacuum in feet of water caused by governor time T

h_b = barometric limit of water column in feet

V_a = absolute velocity of water at top of draft tube, feet per second

e = efficiency of energy regain of draft tube

h_s = static elevation of top of draft tube above tailwater in feet

g = acceleration due to gravity.

Fig. 1 indicates the method of determining this feature.

The calculation of the permissible governor time may be based on a load change from 50 per cent to zero without breaking the draft-tube vacuum, the condition for full load thrown off sometimes resulting in too long a governor time.

If both the above methods show a permissible rate of movement of the gates for full-load change of less than two or three seconds, it is advisable to limit the governor motion to a slower closure. With large units having a rapid stroke, the governor must be quite large and the piping leading to the operating cylinders must be made oversize to avoid high velocities of the governor fluid. Two seconds governor time suffices for ordinary commercial regulation practice, and if a governor time of three seconds is utilized for plants having appreciable length of penstocks even under medium heads, more satisfactory hydraulic conditions will result than from the use of a much shorter time.

THEORY OF SPEED CHANGES

Having fixed, tentatively, the time of governor movement, it is possible to calculate the resulting variation of power input and the energy change in the rotating element; and with this established the speed variation from normal caused by this change in energy is limited only by the flywheel effect of the rotating parts.

In all the calculations in this paper it is assumed that the unit secures no benefit of connected flywheel effect of other generating units, although in actual practice, for small load changes, the connected flywheel effect does assist materially. However, in the cases where the unit is separated from the system by the interruption of service, no assistance is possible in reducing the amount of speed variation which occurs on the particular unit. The actual amount of connected flywheel effect is very difficult to determine, although some tests have been made recently.[5]

Neglecting the effect of water hammer and assuming that the power input to the rotating element decreases uniformly with respect to time as indicated in Fig. 2*a*, the excess power during the time of closure of the turbine gates will be the average between the initial excess amount and zero.

If W = weight of the rotating mass in pounds

n = revolutions per minute

r = radius of gyration in feet

g = acceleration due to gravity, 32.2 ft. per sec. per sec.

N_1 = normal value of speed, and

N_2 = value of speed at the end of the governor stroke,

then the energy which has been absorbed by the rotating mass in increasing the speed of the rotating element is

$$\frac{Wr^2}{5870} (N_2^2 - N_1^2)$$

We may then equate this energy to the amount of energy given up by the water during the closure:

$$\text{hp}_{\text{avg.}} \times T \times 550$$

where T = governor time in seconds, and

$\text{hp}_{\text{avg.}}$ = average horsepower during closure.

Then

$$\frac{Wr^2}{5870} (N_2^2 - N_1^2) = \text{hp}_{\text{avg.}} \times T \times 550 \quad \ldots\ldots\ldots [1]$$

neglecting the energy changes in the penstock due to water hammer and the variation in turbine efficiency during closure.

In the case of full load thrown on the unit from zero the situation is completely reversed, and the energy is given up by the rotating element until the supply has increased sufficiently to equal the demand. With the energy which is in the penstock, due to water hammer, neglected as before, and the assumption made that the energy delivered to the water wheel from the water column increases uniformly from zero to the required amount in a time equal to T (Fig. 2*b*), then

$$\frac{Wr^2}{5870} (N_1^2 - N_2^2) = \text{hp}_{\text{avg.}} \times T \times 550 \quad \ldots\ldots\ldots [2]$$

where $\text{hp}_{\text{avg.}}$ in this case is the average deficiency in power during the opening stroke.

EFFECT OF WATER HAMMER

In considering the rise in speed following a complete loss of load,

[5] Practical Aspects of System Stability, by Roy Wilkins, Jl. A.I.E.E., February, 1926, p. 142.

as the turbine gates close, reducing the velocity in the penstock, an increase in pressure will result, and the horsepower delivered to the generator at any time during the stroke may be obtained from the following formula:

$$\text{hp.} = VHC \ldots\ldots [3]$$

where V = velocity in the penstock in ft. per sec.
Q = discharge in cu. ft. per sec.
H = head on the turbine in ft.
C = constant equal to $0.1136AE$
A = average area of the penstock in sq. ft.
E = efficiency of the turbine at any particular gate opening
w = weight of water in lb. per cu. ft.

C is derived from the relation

$$VHC = \frac{QwHE}{550}$$

whence

$$C = \frac{62.5QE}{550V} = 0.1136\,\frac{QE}{V} = 0.1136AE$$

Since the average penstock area is known, the constant C becomes a function of the turbine efficiency and must be determined at each interval of time. The curve of efficiency with respect to gate opening and the curve of gate opening with respect to time may be determined from tests of similar turbines, and hence the various values of C found in this manner. Fig. 5 gives these relations for a unit having a specific speed of 34.7 based on the movement of the gates being uniform with respect to time.

The rise in pressure due to the reduction in velocity in the penstock may be computed by the method of arithmetical integration as set forth in Mr. Gibson's article mentioned previously. The time intervals must be taken equal to $2L/a$ seconds, where L is the length of the penstock and a is the velocity of the pressure wave; for very long penstocks with correspondingly long intervals of time, it may be desirable to take fractions of intervals. The variation of velocity with respect to time is also obtained simultaneously with the variation of pressure and time, and hence by the application of the constant C the horsepower delivered to the rotating element at any time during the complete closure may be determined.

Equation [1], given above, may then be applied to the increments of change in speed caused by the increments in change of horsepower delivered to the rotating element, and in this case N_1 indicates the speed at the beginning of each interval of time selected and N_2 the speed at the end of that particular interval, which, for the next interval, becomes N_1 and contributes to the calculation of a new N_2 at a subsequent interval. The variation of speed with respect to time can then be plotted directly and the speed at any time during the governor stroke determined, as well as the maximum rise in speed attained. A numerical example for full load thrown off to zero is illustrated in Fig. 6. The following data apply to this numerical example as well as to those covering fractional-load changes and loads thrown on from zero:

Wr^2 = 70,030,000 lb-ft.^{2}
T = 5 sec.
t = dead time = 0
h_0 = 213.5 ft.
Q = 3160 cu. ft. per sec. at 70,000 hp.
Load = 70,000 hp.
Penstock length = 690 ft. (including draft tube)
Penstock diameter = 21 ft.
N_1 = 107 r.p.m.
V_0 = 10.25 ft. per sec. (weighted average velocity as to length of penstock)
Average area = 308 sq. ft.

Working equation for pressure rise:

a = velocity of pressure wave = 4680 ft. per sec. (in this case)

$$\text{One interval} = \frac{2L}{a} = \frac{2 \times 690}{4680} = 0.2949 \text{ sec.}$$

$$B_0 = \frac{V_0}{\sqrt{H_0}} = \frac{10.25}{\sqrt{213.5}} = 0.7015$$

$$B = \frac{V}{\sqrt{H}}$$

$$\Delta H = \frac{a\,\Delta V}{g} = \frac{4680}{32.2}\,\Delta V = 145.25\,\Delta V$$

ΔH = increase in head during one interval
ΔV = destruction of velocity during same interval.

Working equation for speed change:

$$C = 0.1136AE = 0.1136 \times 308 \times E = 34.99E$$
$$\text{hp.} = VHC$$

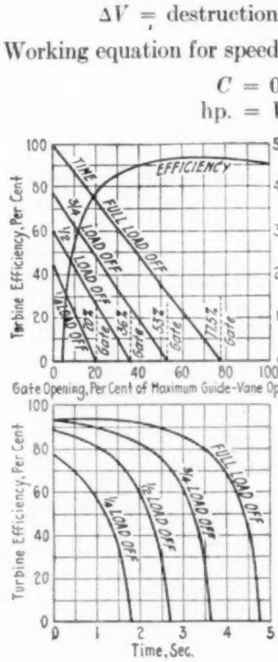


Fig. 5 Variation of Turbine Efficiency with Time for Loads Thrown Off to Zero
(Full load = 70,000 hp.)

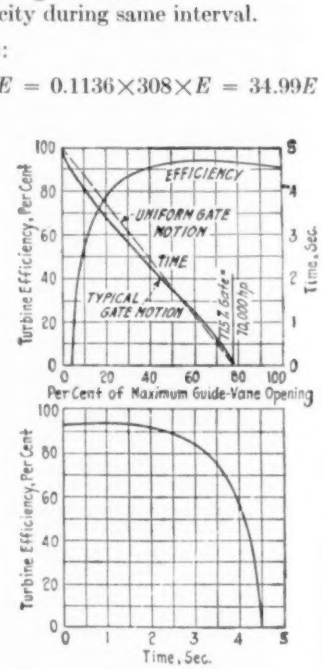


Fig. 7 Comparison of Uniform and Non-Uniform Gate Motion

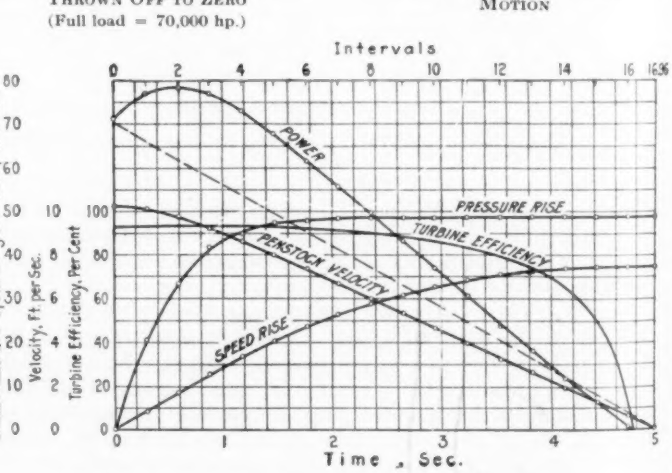


Fig. 6 Speed Rise for Full Load Thrown Off to Zero, Uniform Closure

$$\frac{70{,}030{,}000}{5870}\,(N_2^2 - N_1^2) = \text{hp.} \times 0.2949 \times 550$$

$$N_2 = \sqrt{0.01359\ \text{hp.} + N_1^2}$$

The pressure rise is readily computed and the curves of pressure rise and velocity decrease are drawn as in Fig. 6. The variation of turbine efficiency with respect to time is obtained from the relation of turbine efficiency with respect to gate opening and the relation between gate opening and time as shown in Fig. 5. The curve of gate opening and time in this case is a straight line, assuming uniform closing. The gate-opening values are in per cent of maximum guide-vane opening. The power quantity 71,000 hp. is the power at the turbine shaft at the beginning of the shutdown.

In this example the power consumed by the unit in friction and windage has been subtracted from the average power for each interval. This is a refinement which changes the result by only

0.2 per cent and may therefore be neglected in most cases. If friction and windage are neglected the speed change at the end of five seconds becomes 37.4 instead of 37.2 per cent.

This value of 37.4 per cent shows that the speed rise of 30.6 per cent, obtained above by neglecting water hammer and assuming that the curve of power with respect to time during closure is a straight line, is in error by 6.8 per cent of the normal speed.

The usual movement of the turbine gates with respect to time is not uniform as the mechanism has an inertia effect at the beginning of the stroke, and a cushioning effect at the end. The curve of typical gate motion with respect to time is compared with the uniform movement in Fig. 7. This figure also gives the variation of turbine efficiency with respect to gate opening. From these two

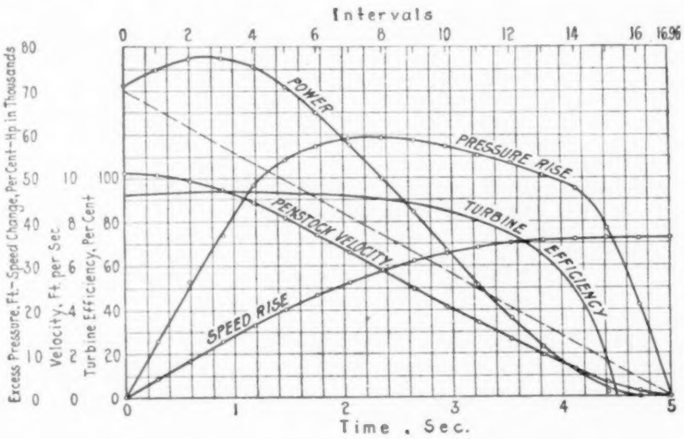


FIG. 8 SPEED RISE FOR FULL LOAD THROWN OFF TO ZERO, NON-UNIFORM CLOSURE

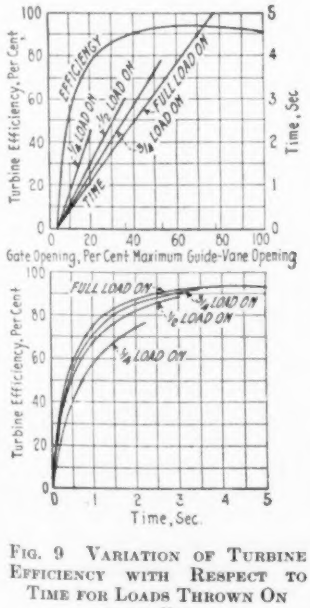


FIG. 9 VARIATION OF TURBINE EFFICIENCY WITH RESPECT TO TIME FOR LOADS THROWN ON FROM ZERO

(Full load = 70,000 hp.)

relations is obtained as before the variation of turbine efficiency with respect to time required in the determination of the constant C.

To illustrate the effect of non-uniform gate motion, calculations have been made for full load thrown off to zero, similar to those illustrated in Fig. 6 but using the typical gate-motion curve in Fig. 7. The results[6] are shown in Fig. 8. It will be noted that the maximum pressure rise has been increased considerably, but that the final speed rise remains about the same, namely, 36.2 per cent as compared with 37.2 per cent above normal with the uniform closure. In the remaining discussion the use of uniform gate closure will be adhered to throughout as, for practical purposes, the difference between the two computations is so small that it need not be considered except in special investigations where such small differences are important.

COMPUTATION OF FRACTIONAL-LOAD CHANGES

It is possible to compute readily the speed changes resulting from fractional-load changes by the same method, using the power and velocities corresponding to the desired load. The time of governor action is not necessarily proportional to the percentage of gate motion, owing to the fact that certain time elements enter into the problem caused by the physical limitations of the governor itself. A typical curve of percentage of time of full stroke, corresponding to the percentages of gate travel, is shown in Fig. 4.

COMPUTATIONS FOR ONCOMING LOADS

The same general method may be applied to the increase in load on the unit from zero, but the deficiency in energy input to the rotating element must be considered, rather than the excess energy as in the case of the rise in speed for rejected loads. This complicates the calculation slightly, but the same fundamental theory obtains. The fall in pressure with respect to time is computed in about the same manner as the rise in pressure. The increase in velocity is then obtained and the power input with respect to time secured as the product of the velocity, the effective head, and the constant C determined as before. This amount of power input to the rotating element is then deducted from the demand, leaving a value of horsepower deficiency which is supplied by the energy of the rotating element. This change in energy is manifested by a reduction in speed in the same manner as the excess energy causes an increase in speed.

Fig. 9 shows the corresponding calculations for the reduction in speed with respect to time for full load thrown on from zero.

It will be noted in the calculations for loads thrown on that the flow has not reached its normal value by the time the gates have completed their stroke. The speed would continue to drop a small amount in addition to the maximum shown, but would be compensated for by an additional opening of the gates beyond the normal position corresponding to the new demand.

By plotting the results obtained from calculations for varying load changes, the maximum speed change for any load off to zero or on from zero may be read from the curve, as shown in Fig. 10.

GENERAL EQUATIONS AND DETERMINATION OF FLYWHEEL EFFECT

Referring to the formula previously given illustrating the change in speed resulting from a change in power input, we find that the expression

$$\frac{Wr^2}{5870}(N_2^2 - N_1^2)$$

represents the energy change in the rotating element caused by a variation of horsepower with respect to time during the gate movement. As the governor time is fixed in accordance with the previous discussion, the variation of horsepower with respect to time is therefore established independently of the flywheel effect of the generator. We may then compute the summation of horsepower with respect to time and equate that to the energy change as noted above. In this case N_2 becomes the maximum speed attained and N_1 the normal speed of the unit. If the permissible speed variation is known, the Wr^2 of the rotating element is automatically determined, from which should be deducted the Wr^2 of the turbine runner and shaft to secure the net Wr^2 in the generator. On the other hand, if it is desired to utilize a given Wr^2 of the generator, the maximum rise in speed is automatically fixed. For any given conditions it is necessary, therefore, only to compute the variation in horsepower with respect to time, take the summation of the various intervals, and substitute them in the following general equation:

$$\frac{Wr^2}{5870}(N_2^2 - N_1^2) = \Sigma(\text{hp.} \times \Delta t) \times 550 \ldots\ldots\ldots [4]$$

The same method may be utilized in connection with the decrease in speed for oncoming loads as given in [5]:

$$\frac{Wr^2}{5870}(N_1^2 - N_2^2) = \Sigma(\text{hp.} \times \Delta t) \times 550 \ldots\ldots\ldots [5]$$

where hp. represents the horsepower deficiency at any time during the opening stroke. It is then possible, by assuming different values of Wr^2 of the rotating element, to compute the corresponding speed variations which will result with a given governor time, and hence establish a curve of Wr^2 versus speed change for any given set of conditions, and from this curve establish the Wr^2 of the generator desired. Fig. 11 illustrates such a curve for the determination of the flywheel effect based on conditions used in the example in Fig. 6.

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6 Tables of calculations containing the data plotted in Figs. 8 to 10, inclusive, were submitted by the authors and may be consulted at the Secretary's office, where they are on file.—EDITOR.

The economical features of the problem in regard to the cost of increased flywheel effect of the generator and the evaluation in terms of money of the speed variation for given load changes determine the allowable flywheel effect to be used. In certain cases where a large number of plants are operating in parallel, the requirements for speed regulation are not as severe as in the case of an isolated plant. Certain apparatus, for example, electrically driven paper machines, require closer speed regulation.

It is usually possible to estimate from observation of similar equipment what the probable maximum and normal load changes will be on a given system. With these determined, the permissible speed variation should be fixed, and then the generator flywheel effect can be determined in the manner described previously to limit the speed variations as desired.

Figs. 12 and 13 show the typical hydraulic-turbine speed variation for loads thrown off to zero and loads thrown on from zero, obtained by averaging a number of the regulation guarantees on units having capacities up to 10,000 hp. under heads ranging from 15 to 90 ft. For large-capacity units or plants involving a moderate length of penstock the general trend of speed changes will be as shown in Figs. 12 and 13. For high heads, long penstocks, or special regulation requirements the guarantees may vary from the usual range.

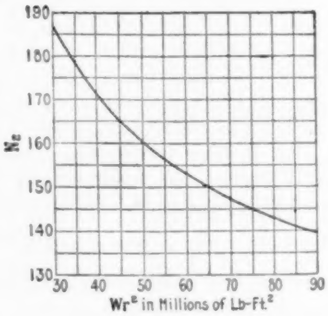

FIG. 11 RELATION BETWEEN MAXIMUM SPEED AND TOTAL Wr^2 FOR 70,000 HP. THROWN OFF TO ZERO IN 5 SECONDS

APPLICATION TO SPECIAL CASES

In connection with computations to determine the amount of voltage rise on transmission lines, the variation of speed with respect to time becomes a very important factor. The time settings on the protective relays on the unit also require a knowledge of the time in which it is necessary for them to act in order to protect the generator.

Another case in which a detailed study is essential is found in the design of an automatic generating station which must be placed in service in a very short time, where calculations are necessary to establish the minimum possible time for building up full load on the unit. In one example studied the unit was equipped with a very long conduit leading up to a surge tank, and from there the water was led through a steel penstock to the Johnson

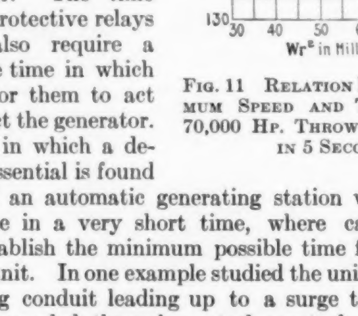

FIG. 10 MAXIMUM VALUES OF SPEED CHANGE FOR VARIOUS LOAD CHANGES ON 70,000-HP. TURBINE

valve at the entrance to the turbine casing. The plant would be started by means of an automatic centrifugal device, which would come into service in case the system frequency fell below a limiting value. The unit would be operating at synchronous speeds with the Johnson valve closed, and the automatic devices would open the Johnson valve and turbine gates, throwing full load on the unit in a period of a few seconds.

Allowance was made for the change in level of the surge tank, the throttling effect through the partially opened Johnson valve, and the fall in pressure due to acceleration of flow, and the resultant change in speed of the unit determined, considering that full load was required. Two values of Wr^2 were selected, and it was found possible to limit the drop in speed to 31.7 per cent with full load thrown on from zero.

EXCESS-POWER RATIO

Referring to the general Equations [4] and [5], the expression $\Sigma(\text{hp.} \times \Delta t)$ represents the integration of excess or deficiency in horsepower with respect to time. By substituting for this expression the product of the actual load thrown off or on, as the case may be, and the full governor stroke T, the water-hammer effect may be compensated by the addition of a suitable constant K.

For loads thrown off to zero the equation will be

$$\frac{Wr^2}{5870}(N_2^2 - N_1^2) = \frac{\text{hp.}}{2} \times T \times 550 \times K_1 \ldots\ldots \quad [6]$$

The constant K_1 may be called the excess-power ratio, which is in reality the ratio of the actual summation of horsepower with

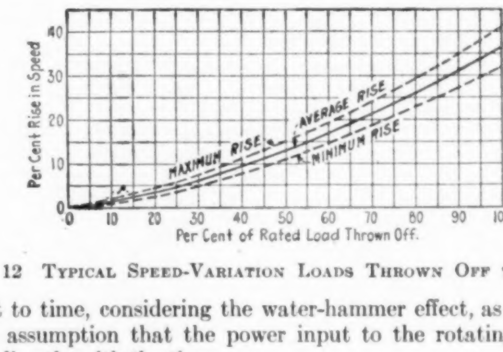

FIG. 12 TYPICAL SPEED-VARIATION LOADS THROWN OFF TO ZERO

respect to time, considering the water-hammer effect, as compared to the assumption that the power input to the rotating element varies directly with the time.

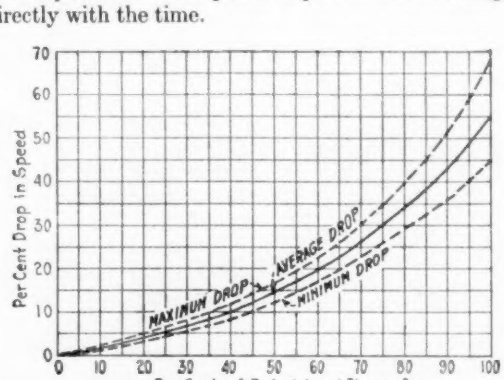

FIG. 13 TYPICAL SPEED-VARIATION LOADS THROWN ON FROM ZERO

For loads thrown on from zero the equation will be

$$\frac{Wr^2}{5870}(N_1^2 - N_2^2) = \frac{\text{hp.}}{2} \times T \times 550 \times K_2 \ldots\ldots \quad [7]$$

The constant K_2 in this case is the ratio of the summation of the deficiency in power with respect to time as compared to the uniform variation previously assumed.

By establishing these factors for various conditions, based on detailed calculations, it will be possible to combine them in the equation and solve for the speed variation directly.

The efficiency of the turbine also comes into the determination of the constants K_1 and K_2, and since the efficiency will vary with the load and the gate opening, it is necessary to determine the variation in efficiency with respect to time and find the weighted mean thereof for the full stroke in order to apply it to the excess-power ratios determined without respect to efficiency. For part-load changes the efficiency of the transfer of energy differs from that of full-load changes, since the initial output is usually at a lower efficiency than at full load, and consequently the energy absorbed by the rotating element is less than it would be where the efficiency is higher, as in the change from full load to zero.

With these factors determined by detailed study, the authors believe that it is possible to arrive at an approximate formula without the necessity of performing the arithmetical-integration method of calculation for the variation in horsepower with respect to time.

Auxiliaries for Motor Vessels—I[1]

An Analysis Showing That Certain Types of Vessels Can Be Built and Operated with More Profit Than Others, and Disclosing Reasons Why a Searching Investigation of Ships' Economies Should Be Made When Selecting the Type of Machinery

By JOHN W. MORTON,[2] and A. B. NEWELL,[3] CAMDEN, N. J.

DUE TO variations in types of ships and propelling engines the necessary auxiliaries vary to such an extent that standardization is almost impossible. Auxiliaries on board a ship will vary according to the character of the ship's service. Each ship is likely to have a different kind of installation. The mode of drive and whether or not the ship is new or converted are factors influencing the installation.

To the shipowner who has decided to install Diesel engines as the propelling unit in his vessel, the selection of suitable auxiliary machinery is a question worthy of special consideration and presents greater difficulties with oil-engined vessels than with steamers. With the latter, either the donkey boiler or the main boiler supplies all the steam necessary for all auxiliary machinery. When the appalling inefficiencies of the steam-driven auxiliaries are considered, one wonders why such extravagance is still permitted.

Steam Versus Electric Auxiliaries

In vessels above, say, 2000 tons deadweight capacity, it is advisable to arrange the steam plant in two or more units, in order to facilitate repairs or examinations. In special cases, such as oil carriers, where steam is required almost continuously for tank heating, etc., steam auxiliary machinery will not readily be displaced, but a combination of steam and electrically driven auxiliaries is a very satisfactory alternative.

The electrically driven auxiliary machinery now available for marine work is in every respect as reliable in service as the best type of steam plant, and possibly calls for less attention to maintain.

Steam machinery for engine-room and deck purposes can be relied upon to give continuous service under sea-going conditions with low upkeep cost, but in vessels propelled by Diesel engines it should be observed that the fuel required for auxiliary purposes at sea will amount to from 30 to 35 per cent of that used by the main propelling machinery.

With electric auxiliaries using current generated by Diesel-driven generators, the fuel required for auxiliary purposes at sea will not exceed 5 per cent of that required by the main engines. Also, when working cargo, the electric winches perform the same work as steam winches, with a saving of approximately 90 per cent of the fuel.

The electric auxiliary machinery has a higher initial cost. However, against this must be set the cost of the extra fuel continuously required if a steam plant is used. High-speed steam engines are also very economical in the use of lubricants.

In the past, an electric plant in sea service has been considered to require much more attention than steam gear. That this is not now the case is clearly proved by the large number of such installations in completely successful service. For use on board ship, none but the best class of electric gear should be fitted. Motors and control gear for deck use should be of the watertight enclosed type, special attention being given to the rating of the motors and resistances in view of the high temperatures in which operation may be required.

It is amazing to see the treatment which winch-control gear may have to endure, due to unskilled labor. Further, the method of handling cargo varies in different ports. These points must receive the careful consideration of the designers of deck machinery.

Direct current is in general used on board ships now, 220-volt for power purposes and 110 for lighting, being obtained by a motor-generator set and balancer system. With high voltage a considerable saving in the cost and weight of the cables and motors is obtained.

All-Electric Auxiliaries

In vessels with all-electric auxiliary machinery, it has been found, except in very special cases, that three Diesel-driven generators is the minimum number fitted, the output of each generator being so proportioned that two engines will be capable of handling the maximum current demand under maneuvering conditions. With this arrangement, one generating set can always be under periodic examination or overhaul.

The auxiliary generating sets of the direct-connected type generally run at from 300 to 400 r.p.m. Such speeds give comparatively light engines and dynamos, but in service the engines require a large amount of attention. Choosing the right kind of auxiliary sets for the particular type of installation is a personal problem with the shipowner or operator, but the author's opinion is that a moderate-speed, multiple-cylinder type of direct generating set as an auxiliary will give the least trouble.

Dynamos are generally of the open, splash-proof type; all motors in the engine room are likewise of this type, or, as is the case with the motors for deck machinery, of the enclosed, ventilated type.

One should consider the alternative methods of powering or driving auxiliaries, the methods available, the advantages and disadvantages, and notes concerning their installation and operation. In case of steamships using steam power for main engine and auxiliaries, this represents no difficulty. If powering by oil engine is adopted it means:

1 A separate engine for each machine, or
2 A generating station in the main or auxiliary engine room for the whole ship, or
3 A combination of (1) and (2).

The separate engine is practicable for each air compressor, winch, capstan, windlass, pump, and the electric light, but not as convenient for the steering gear.

Winches

Fig. 1 shows a method of driving the winches from an oil engine located in the deck house between hatchways. How economical such a drive is, it is hard to say. Such a central drive will have to be operating continuously, and the oil engine will have to be large enough to drive all the winches at any moment, although only one winch may be working. Other drawbacks to such an installation are the isolation of the units, the general overall inefficiency compared to a "central station," and the high initial cost and increase in cost of installation. The advantages of a central station and powering by electricity are the great convenience and flexibility.

Oil power has not the same flexibility as steam power, but improvements are always forthcoming and there is an attempt to do away with steam as far as possible in an internal-combustion-engined vessel.

Use of Compressed Air

Air has been used to a certain extent as an auxiliary power medium, especially for the steering gear, while experiments have been made on deck winches as well. An incorrect analogy between steam and air is often drawn. It takes only 2 to 3 per cent more

[1] By J. W. Morton. Part II and the discussion on the complete paper will appear in the August issue.

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heat to generate steam at 100 lb. pressure than at 10 to 20 lb. pressure, but with air every extra pound of pressure demanded over the pressure actually required means using so much extra power in driving the compressor. The advantage lies in using air at a low pressure.

A simple low-pressure air compressor in the engine room could be used, and the air taken to the winches at 25 to 30 lb. The losses due to leakage are very much less than with steam. Only one pipe is needed from air compressor to winch. If suitable arrangements are made by gearing, then on the few occasions that a heavy lift is required, 20 lb. can still be used, and the load lifted more slowly.

Obviously the ordinary steam steering gear will operate just as well with air as with steam. The quantity of air used for steering is surprisingly low, the quantity used to keep a 5000-ton vessel on her course having been found to be only 20 cu. ft. of free air per min.

This same ship on a trip from England to America and back, in fine weather with a skilful helmsman, used no more than 35 to 40 cu. ft. of air per min. In heavy weather during eight hours of steady observations, the average quantity required was about 90 to 95 cu. ft. per min.

In some motorships, several steam pumps for intermittent service will be connected to an air line, the air being generally supplied by bleeding the starting-air tanks through reducing valves. In a vessel of about 2000 tons deadweight capacity and propelled by a Werkspoor Diesel engine, the owners, thinking that the usual alternative schemes available for driving auxiliary machinery were either very costly, in the case of Diesel-engine-driven dynamos with electrically driven engine-room auxiliaries, winches, etc., or wasteful, as in the steamship with steam-driven donkeys and deck machinery, finally arranged a compromise layout which has effected excellent results, both as to low production cost and economy in service.

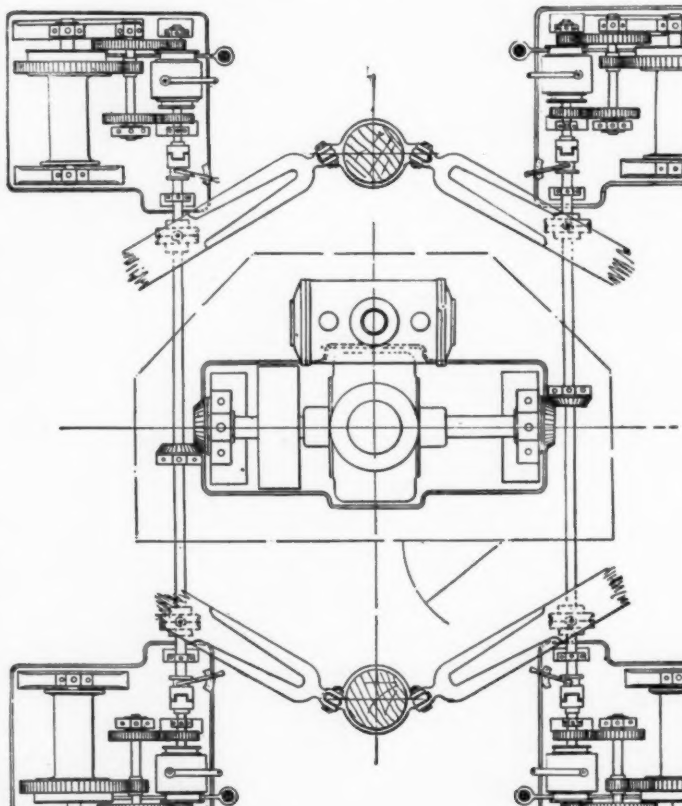

Fig. 1 Method of Driving Winches from an Oil Engine Located in the Deck House Between Hatchways

(Reproduced from Internal-Combustion Engines, published by the Institute of Marine Engineers, London, 1922.)

The engine-room auxiliaries and deck machinery are steam-driven, but for sea service the pumps are all driven directly from the main engine. Steam is generated by passing the engine exhaust gases through two Scotch boilers, each having 430 sq. ft. of heating surface, the maximum working pressure being 150 lb. per sq. in. A pressure of 110 to 120 lb. per sq. in. can thus be maintained, and the steam drives the steering gear and heats the saloon and crew's quarters. When entering or leaving port, the boiler burners are lighted, and sufficient steam is immediately available for driving the auxiliary air-compressor windlass, etc. Electric light is supplied by a small dynamo driven by a semi-Diesel engine of 20 hp. which consumes about 0.05 ton of oil per day. The steam-driven auxiliaries are as follows: one simplex ballast pump, with a capacity of 130 tons per hour, one simplex feed pump for the boilers, and one simplex fuel-transfer pump. The boiler burners are fed by an efficient pneumatic device. For handling cargo in port a two-cylinder uniflow engine of 160 i.hp. is provided, which drives two lines of shafting through disengaging clutches, one going forward and the other aft. The shafting is provided with flexible couplings to allow for the curvature of the deck, and with special bevel gears encased in cast-iron grease boxes for driving the athwartship lines to which the winches are coupled.

The shafting takes up no more space than the usual winch steam and exhaust pipes. After 18 months' use the teeth of the bevel gears were quite bright and showed no measurable wear. The windlass and each winch are provided with a friction clutch of special construction, designed to comply with the various conditions met with on shipboard, and the measured average fuel consumption is 156 lb. per hr. or about 1.7 tons per day. The initial cost of this system is higher than for steam winches, but it is much more economical in steam consumption. If a Diesel engine were substituted for the uniflow steam engine, a further substantial reduction of fuel consumption would result.

As oil tankers are in a class by themselves, and a large amount of steam is needed for cargo heating at sea, it is only natural to use steam auxiliaries. Conversion of existing steamships to motorships presents also a special problem, one which is largely determined by the type of vessel and the kind of trade in which it is to engage.

Fuel Consumption

The motorship *Cubore* (ore carrier) originally had several electric-motor-driven engine-room auxiliaries and an electric steering gear, all other engine-room and deck machinery being steam-driven with steam supplied from a donkey boiler. After a few years' operation the main engines were altered and at the same time the entire steam plant was removed and electric-motor-driven auxiliaries installed throughout.

It was further stated that "the boiler was a constant source of annoyance, steam having to be kept up at sea for stand-by purposes. Such large quantities of fuel oil were burned that the saving in maintenance and operation has been considerable and the installation of all-electric auxiliaries has effected an improvement all around. In addition, the boiler took up considerable floor space and crowded the engine room."

TABLE 1 OIL CONSUMPTION AND SAVING DUE TO CHANGE TO ELECTRIC AUXILIARIES, MOTORSHIP *CUBORE*

	Oil Consumption			
	Steam auxiliaries		Electric auxiliaries	
	Tons	Barrels	Tons	Barrels
At Sea				
Boiler	58.143	407	......	...
Auxiliary Diesel generators	18.429	129	21	147
In Port				
All auxiliaries	17.285	121	2.285	16
Total	93.857	657	23.285	163
Saving	......	...	70.572	494

Table 1 gives the average fuel-consumption figures obtained from several round trips of the motorship *Cubore* to Chile with and without the steam auxiliaries, and illustrates the saving in fuel when using electric auxiliaries. It should be borne in mind, that the deck machinery is not used for either loading or unloading cargo.

The motorship *Seekonk* converted by the Wm. Cramp & Sons Ship & Engine Bldg. Co. is fitted with all-electric auxiliaries as follows:

Auxiliary Machinery

3 100-b.hp. Diesel-engine generators (65 kw.)
1 donkey boiler for heating, fire smothering, and heater coils at fuel-oil suctions.

Deck Machinery

1 hydroelectric steering gear
10 3-ton electric winches
1 windlass, electrically driven
1 capstan, electrically driven.

Comparing figures with results obtained from steam sister ships of the *Seekonk*, the data of Table 2 are available.

TABLE 2 COMPARISON OF OIL CONSUMPTION ON STEAMERS AND MOTORSHIPS

	Steamer *Hog Island*	Motorship *Seekonk*
Fuel per day at sea, main and aux. engine, tons (av.)	29.14	7.416
Donkey boiler, tons (av.)	....	0.513
Fuel per day in port[1] (rivers and harbors, etc., inclusive), tons	9.00	1.22
In port alone, tons	....	0.60

[1] The consumption in port varies from 0.3 to 1 ton, depending on whether the winches and donkey boiler are in operation, with a mean of about 0.7 ton during winter and 0.5 during summer months.

The motorship *Ashbee* converted by the New York Shipbuilding Corporation is fitted with steam deck machinery (except the steering gear, which is hydroelectric); that is, the existing deck winches, capstan, and windlass were retained.

The Sun Shipbuilding Company has converted the motorships *Bidwell*, *Miller County*, and the *Challenger*. The first two retained all their steam auxiliaries, whereas on the *Challenger* electric auxiliaries were fitted.

Table 3 is a summary of the cases cited.

1 Both types of winches perform the same duty
2 Stevedoring charges are the same for both types
3 The period of time for loading and discharging is the same in both cases
4 The personnel is the same in both cases
5 The steering gear is hydroelectric in both cases.

The outstanding features of the two types of deck machinery are the following:

Ship with Steam Winches

1 Extra deadweight carried, or less net cargo carried
2 Fuel oil, lubricating oil, feedwater, etc., consumption larger in port
3 Lower initial cost.

Ship with Electric Winches

4 Greater net cargo carried
5 Less expense for power while in port
6 Higher initial cost.

The difference between (6) and (3) should, in the lifetime of the ship (or less), compensate or outweigh the other differences due to higher cost of handling a ton of cargo in port.

It is understood, however, that due consideration to percentage of depreciation, insurance, and profit must be given in each case, and as the motorship of today is fully as reliable as the steamship, it is only fair to figure both on the same basis. This is generally 5 per cent per annum for depreciation, 5 per cent per annum for insurance, 8 per cent per annum (min.) profit on capital invested, giving 18 per cent per annum total.

TABLE 3 COMPARISON OF SIX MOTORSHIPS

	Cubore			*Seekonk*		*Ashbee*				
	Average results of steamers practically same size	As motorship: With steam aux.	As motorship: With Diesel-elec. aux.	Average results of steamer sister ships	As motorship	As steamer	As motorship	*Bidwell*	*Miller County*	*Challenger*
Length, overall, ft-in	.....	.....	468–$2\frac{5}{8}$	.....	401–$0\frac{7}{16}$	....	346–6	....	......	......
Length, b.p., ft-in	.....	.....	450–7	.....	390–0	....	334–6	430–0	430–0	410–0
Breadth, molded, ft-in	.....	.....	57–0	.....	54–0	....	48–0	59–0	59–0	56–0
Depth, to upper deck, ft-in	.....	.....	......	.....	32–0	....	27–6	....	......	......
Depth, molded, ft-in	.....	.....	37–0	.....	27–6	....	24–9	33–3	33–3	38–0
Draft, loaded, ft-in	.....	.....	27–$6\frac{25}{32}$	.....	24–$5\frac{3}{16}$	....	22–$5\frac{1}{2}$	....	......	30–6
Displacement, loaded, tons	.....	.....	15,992	.....	11,400	....	8,125	14,760	14,760	15,930
Deadweight, tonnage	.....	.....	11,000	.....	7,754	....	5,532	10,260	10,260	11,620
Speed, knots	.....	.....	10	.....	10.25	....	10	12.5	12.5	13.85
Brake horsepower	.....	.....	2,400	.....	1,770	....	1,500	2,500	2,500	2,500
Fuel per day at sea, main and auxiliary total, tons	33.48	.....	12.05	29.14	7.416	24.6	6.92	9.3	10.3	12.0
Main engine only, tons	.....	.....	11,478	.....	......	....	.....	....	......	......
Auxiliaries only, tons	.....	0.502	0.572	.....	......	....	.....	....	......	......
Donkey boiler only, tons	.....	1.58	......	.....	0.513	....	.....	....	......	......
Fuel per day in rivers, harbors, etc., tons	.....	.....	......	22	5.93	....	.....	....	......	......
Fuel per day in port, total, tons	11.43	.....	0.57	8	0.6	7.6	1.43	3	3	1.33
Auxiliary engine only, tons	.....	0.47	0.062	.....	......	....	0.14	....	......	......
Donkey boiler only, tons	.....	.....	......	.....	......	....	1.29	....	......	......

From the foregoing, the electric auxiliary is evidently more economical than the steam, but how much of this saving, if any, is due to the use of electric deck machinery is a question that only can be solved for each particular case.

Comparison of Steam and Electric Winches

The advantages of the steam winch are as follows:

1 It is flexible and easy to repair
2 It will stop when the strain is too great, but the steam being just behind the valve, it is ready to pick up the load when the strain is relieved
3 The first cost is low.

The disadvantages of the steam winch are the following:

1 It requires a large boiler with all its auxiliaries; condenser, pumps, etc.
2 Large feedwater capacity must provide for the loss by condensation, leaks, etc., and
3 Long pipes decrease the overall efficiency.

The added apparatus means higher upkeep and repair expenses, and additional spares to be carried. The larger deadweight carried reduces the net cargo capacity and thereby the yearly revenue.

The comparison of the hypothetical ships made below is based on the following assumptions:

Waste-Heat Boilers

Reliable information on the waste-heat boiler is rather scarce. Until recently the impression has been given that such boilers are a failure.

Although the exhaust gases carry away about 30 per cent of the total heat of combustion, the amount of heat that can be extracted and used for steam production is very much less, especially in two-stroke engines, where the exhaust gas is diluted with scavenging air and has a lower mean temperature. Size and length of manifold, as well as location of waste-heat boiler, are other factors influencing the efficiency.

The gases generally leave the cylinder at a pressure of from 20 to 40 lb. per sq. in. and a temperature of from 600 to 1000 deg. fahr. By passing the exhaust gases from gas engines through a waste-heat boiler, it is possible in every-day practice to obtain an evaporation of slightly more than 2 lb. of water from and at 212 deg. fahr. per b.hp-hr. of the engine. In Diesel engines the thermal efficiency is higher than in gas engines and the temperature of the gas lower, which means that the output of steam available from the exhaust heat will be less per b.hp-hr. In actual practice on large engines, 0.8 to 1.2 lb. (with a mean of 1 lb.) of water from and at 212 deg. fahr. per b.hp-hr. has been evaporated at an exhaust temperature of around 600 deg. fahr.

Waste-heat boilers are generally fitted as a separate boiler unit, or, where steam boilers are retained for steam auxiliaries,

the main boilers themselves are provided with an arrangement for cutting in and out the fuel-oil burners, and have proper bypass valves, generally of cast iron, with valves of the "flapper" or butterfly type of the same material.

Having manifolds, pipes, and valves all of cast iron, which of course is the ideal material, the weight (and thereby the price) is increased considerably. The life of steel pipe may not be the same as that of cast-iron pipe, but the price difference, weight, and installation might offset this to a certain extent.

The amount of steam in lb. per b.hp-hr. can be determined by the formula:

$$w = \frac{Qgh[T_1 - (T_2 + t)]}{(e - f)T_1}\eta$$

where T_1 = temperature of exhaust gas, deg. fahr.
T_2 = temperature of water or steam, deg. fahr.
t = temperature of gas leaving boiler over and above the temperature of hot water in boiler, deg. fahr.
H_1 = percentage of heat utilized in the boiler of the total carried by exhaust gas
H_2 = total heat developed per b.hp-hr., B.t.u.
Q = calorific value of fuel, B.t.u. per lb.
g = fuel consumption, lb. per b.hp-hr.
h = ratio of total heat carried by exhaust gas and that of total heat of fuel burned
e = total amount of heat required to evaporate 1 lb. of water of the initial temperature t_1 = 32 deg. fahr.
f = heat contained in the water of temperature T_3, B.t.u. per lb.
η = efficiency of boiler, per cent
w = amount of steam generated, lb. per b.hp-hr.

For practical purposes h is generally about 30 per cent or 0.30, and g can be taken as 0.43 lb. per b.hp-hr. The boiler efficiency η can be taken as 90 to 95 per cent.

From the above formula it is apparent that a lower pressure in the boiler is advantageous, and the higher temperature of the exhaust gas essential. Thus the four-stroke engine is more suitable for working with a waste-heat boiler than a two-stroke one, which has lower temperature of the exhaust gases. The type of vessel, machinery installed, service intended for, routes, etc., are factors to be considered in the installation of a waste-heat boiler as well as the design and construction of the boiler itself.

Determination of Costs

The number of days n for one trip is

$$n = \frac{L}{24V}$$

where L = length of trip in nautical miles
V = speed of ship in knots.

The number of single trips per year N is

$$N = \frac{365 - d}{\dfrac{L}{24V}} = \frac{(365 - d)24V}{L}$$

in which d = days in port or otherwise not sailing; or

$$N = \frac{365}{\alpha\dfrac{L}{24V} + \beta\dfrac{2t}{r}}$$

in which α and β are coefficients to take account of bad weather and delays in port, respectively, and

$2t/r$ = days in port, loading and discharging
t = net cargo, deadweight per trip, tons
r = rate of loading and unloading, tons per day.

Fuel, stores, etc. required at sea $= \dfrac{L}{24V}(F + w + O + S)$

in which F, w, O, and S refer to fuel, water, oil, and stores, respectively, at sea in tons per day.

Fuel stores, etc., required in port $= \dfrac{2t}{r}(f + w_p + O_p + S_p)$

in which f, w_p, O_p, and S_p refer to fuel, water, oil, and stores respectively, in port in tons per day. Hence T, the gross cargo deadweight in tons per trip, is

$$T = \left[\alpha\frac{L}{24V}(F + w + O + S) + \beta\frac{2t}{r}(f + w_p + O_p + S_p) + t\right]$$

and

$$t = \frac{T - \alpha\dfrac{L}{24V}(F + w + O + S)}{\beta\dfrac{2}{r}(f + w_p + O_p + S_p) + 1}$$

which can be written as

$$t = \frac{T_0 - \alpha F_0}{\beta f_0} \quad \text{or} \quad \frac{T_0 - F_0}{f_0}$$

where T_0, F_0, and f_0 refer to the total, at-sea, and in-port tonnages, respectively. For maximum t or maximum cargo carried, F_0 and f_0 must be minimum.

The freight revenue B is therefore

$$B = N \times t \times R$$
$$= \frac{365 - d}{\dfrac{L}{24V}} \times t \times R$$
$$= \frac{(365 - d) \times 24 \times R}{L} \times V \times t$$

in which R = freight rate in dollars per ton. Then, if L and d are constant, putting

$$\frac{(365 - d) \times 24 \times R}{L} = k_1$$

gives

$$B = k_1 \times V \times t$$

Net cargo weight can also be expressed by

$$t = \Delta - (W_1 + W_2 + W_3 + W_4)$$

in which Δ = displacement in tons and W_1, W_2, etc., are the weights in tons of the hull, running gear, machinery, fuel, etc. Then, writing

$$W_1 + W_2 + W_3 + W_4 = \Sigma W$$

gives

$$t = \Delta - \Sigma W$$

and

$$B = k_1 \times V \times (\Delta - \Sigma W)$$

One expense item, E, is approximately constant relative to the effectivity of the ship, and can be expressed as a function of the freight revenue, or

$$E = \delta \times B$$
$$= \delta \times N \times t \times R$$

in which E = expenses of crew, maintenance, insurance, repairs, etc.; if

$$\delta \times R = k_2$$
$$E = k_2 \times N \times t$$

Another item of expense, E', depends on the number of trips and the cost of oil, water, port charges, etc.

$$E' = N\left[\alpha \times n(FC_1 + wC_2 + OC_3) + \beta\frac{2t}{r}(fC_1 + w_pC_2 + O_pC_3) + ti\right]$$

in which C_1, C_2, and C_3 are the costs of fuel, feedwater, and lubricating oil in dollars per ton, and i = cost of loading and discharging in dollars per ton.

$$N = \frac{(365 - d) \times 24}{L} \times V$$

Now putting

$$\frac{(365-d) \times 24}{L}\left[\alpha n(FC_1 + wC_2 + OC_3) + \beta\frac{2t}{r}(fC_1 + w_pC_2 + O_pC_3)\right] = k_3 \times W_4$$

gives

$$E' = k_3 \times W_4 \times V + N \cdot t \cdot i$$

Total expenses can thus be expressed by

$$D = E + E'$$
$$= k_2 \times N \times t + k_3 \times W_4 \times V + N \cdot t \cdot i$$
$$= N \times t(k_2 + i) + k_3 \times W_4 \times V$$

The depreciation a is directly proportional to the initial cost A and inversely proportional to the lifetime J. Therefore

$$a = \frac{A}{J}$$

and if J is a constant,

$$a = k_4 \times A$$

The initial cost is composed of cost of hull, running gear, equipment, outfit, etc., and machinery, whence

$$a = k_4(p_1W_1 + p_2W_2 + p_3W_3)$$

Calling $\Sigma k_1 = K_1$, $\Sigma k_2 = K_2$, $\Sigma k_3 = K_3$, and $\Sigma k_4 = K_4$, then

$$\Sigma P = K_1Vt - K_2Nt - K_3VW_4 - K_4(p_1W_1 + p_2W_2 + p_3W_3)$$
$$= V(K_1t - K_3W_4) - K_2Nt - K_4(p_1W_1 + p_2W_2 + p_3W_3)$$

which again shows that the yearly income depends on (1) cargo capacity, t, (2) speed of vessel, V, and (3) weights of the different groups, W.

For ΣP to be maximum, $\partial\Sigma P$ must be equal to zero. For the special case that K_1 is equal to K_3 and the remaining part of the equation to the right remains constant, we have maximum ΣP expressed by

$$t - W_4$$

For the ship equipped with the steam winch,

$$\Sigma P_s = t_s - W_{4s} - t_s \times i_s$$
$$= t_s(1 - i_s) - W_{4s}$$

and for the ship equipped with the electric winch,

$$\Sigma P_e = t_e - W_{4e} - t_e \times i_e$$
$$= t_e(1 - i_e) - W_{4e}$$

It is evident that for maximum P_s or P_e, i_s or i_e must be minimum, as well as W_{4s} and W_{4e} and that the pro and con hinge on the two factors i_s and i_e. Now the difference in cost of the two ships is

$$U = A_e - A_s$$

in which A_e and A_s are the costs of the electrically and steam-equipped ships, respectively, and this, considered as a sinking fund, must in years balance the cheaper operating expense in favor of i_e.

The annual payment Y which will amount with accumulated interest to the given sum U at the end of x years is equal to

$$Y = U \times y$$

where

$$y = \frac{0.01r}{(1 + 0.01r)^x - 1}$$

with r = interest, per cent per annum. Then

$$U \times y = N(i_s - i_e)$$

or

$$U \times \frac{0.01r}{(1 + 0.01r)^x - 1} = N(i_s - i_e)$$

and

$$\frac{U \times 0.01r}{N(i_s - i_e)} + 1 = (1 + 0.01r)^x$$

of which x can be found when i_s and i_e are known factors. The interest r is generally predetermined.

From data, appearing in the press founded upon experience and records collected (see also Table 3), the ratio between fuel consumed in port by steam auxiliaries and fuel consumed by electric auxiliaries is about equal to

$$\frac{f_s}{f_e} = \frac{10}{1}$$

and if everything else is equal or constant, this gives a good index of the items i_s and i_e. Likewise for most motorships there is a somewhat constant ratio between fuel oil and lubricating oil consumed, as follows:

$$\frac{F}{O} = \frac{200}{1}$$

Feedwater consumed has a relation to fuel oil burned, and for practical purposes can be written

$$\frac{F}{\text{steam or water}} = \frac{12}{1}$$

Compressors and Air Storage

Compressed air as a medium is used to a wide extent for injecting and atomizing oil for the cylinder of a Diesel engine. When the Diesel engine was introduced for marine work and large units were made reversible, the capacity of the air compressor was made rather large compared to that for a stationary engine of the same power. The last ten years have seen wonderful improvement in the reliability of the air compressors for marine-type Diesel engines.

To a certain type and size of ship there always corresponds a certain number and size of auxiliaries, and to minimize these without impairing or sacrificing the overall reliability and reserve service should be the chief aim of both engineers and manufacturers, although they are to a certain extent handicapped by the rules and regulations promulgated by the different classification societies.

In earlier Diesel engines an allowance was made for air-compressor capacity of approximately 0.5 cu. ft. per min. per b.hp., a figure now almost cut in two for modern engines. The volumetric efficiency of some of those early compressors, mostly two-stage, left much to be desired, being around 60 per cent. The present three-stage air compressor fitted for Diesel-engine work has a volumetric efficiency of at least 80 per cent, and in some cases it is as high as 90 per cent.

To base the size of air compressors for marine work on the cu. ft. of free air per min. per b.hp. or on compressor- to-cylinder-volume ratio is possible only where experience is the judge. A number of textbooks, magazines, etc. give a range varying from 1:12 to 1:24, where the small value is to be taken for large engines, and the large value for small engines, also certain values in proportion to the number of cylinders, as follows: If value A equals the compressor- to-cylinder-volume ratio and is taken as 1:14 and based on a one-cylinder engine, then, with the increase in number of cylinders, the value of A changes as follows:

Number of cylinders..........	1	2	3	4	4	6	8
Value of A....................	1:14	1:16	1:18	1:20	1:22	1:24	1:26

The capacity of both air compressors and storage tanks also affects weight, space requirements, and cost of production. The ideal capacity of course is the one with minimum capacity but still large enough for emergency purposes.

Comparison of Shipping Rules

The rules of the classification societies are given below.

American Bureau of Shipping

The number and capacity of the main air compressors should be ample to supply the air requirements of the main engines for a range of from 30 per cent to the full normal rated shaft power.

Single-screw ships having main engines with attached or one independent main compressor are to have in addition one or more independent auxiliary compressors of ample capacity to supply the air requirements of the main engine at half the normal rated shaft horsepower.

Twin-screw ships having main engines with attached or independent main compressors are to have in addition one or more independent auxiliary compressors of ample capacity to supply the air requirements of one main engine at half its normal rated shaft horsepower. Where each independent main compressor has sufficient capacity to furnish the required air for the normal rated shaft horsepower of one engine and in addition for half the normal rated shaft horsepower of the other engine an auxiliary compressor will not be required.

Twin-screw ships having main engines with one independent main compressor for supplying both engines are to have in addition one or more independent auxiliary compressors of ample capacity to supply the air requirements for the normal rated shaft horsepower of one engine or for half the normal rated horsepower of both engines.[4]

Lloyd's

In single-screw vessels, an auxiliary air-compressor is to be provided of sufficient power to enable the main engine to be kept continuously at work, when the main compressor is out of action.

If the maneuvering gear is arranged so that the engines can be kept continuously at work with some of the cylinders out of action, the auxiliary compressor need only be of sufficient power to enable engines to be kept at work under these conditions.

In the twin-screw vessels, in which two sets of compressors are fitted, the auxiliary compressor is to be of such size as to enable it to take the place of either of the main compressors.

If in such engines each main compressor is sufficiently large to supply both engines, a smaller compressor will be sufficient.

In determining the capacity of the auxiliary compressor due consideration should be given the air requirements for maneuvering the vessel.

Horsepower, speed of vessel, and air-injection pressure and consumption, are so interrelated that unless a definite rule for minimum speed of a vessel under adverse circumstances or distress is laid down, it is rather difficult to reach a happy medium or minimum figure in which all emergencies are met and still remain on the safe side. Much is dependent on having reliable auxiliaries of proper capacity, for capacity is a function of (1) speed of vessel (function of time), (2) money (function of speed).

Before formulating the capacities of the air compressors based on experience and data, it is well to look into the fundamental principles involving the use of air for injection purposes.

The injection-air pressure required depends on the type of fuel valve, the viscosity of the fuel used, the shape of combustion chamber, and the load and the speed of a given engine, from which it follows that best economy of air consumption is obtained when the fuel-valve lift is regulated to suit load and r.p.m.

If the horsepower vs. r.p.m. curve for a given engine is known as well as the most economical and beneficial injection pressure, it is easy to plot the most suitable injection pressure for partial loads.

[4] In addition, both societies require a small auxiliary injection-air compressor, entirely independently driven as an extreme emergency. Therefore, as this compressor is only a very small outfit, only the large auxiliary and main compressors are considered.

Fig. 2 gives some interesting curves representing injection pressures for a given percentage load in horsepower.

The effect of variation of the injection-air pressure at different loads on the fuel consumption is illustrated in these curves, and it will be noted that there is a definite, most efficient injection pressure for each load. It will be noted that the curves A, F, and D, and to a certain extent also curve E, are nearly parallel, giving a relation between injection pressure and load at maximum economy, or in other words, most efficient combustion; whereas curves B and C are left to the operating engineer and a "hit or miss" regulation, without any guide for efficient combustion. The great necessity of an automatic regulation of injection-air pressure and fuel-valve lift for maximum economy can be seen. The curves will also reveal the increase in injection pressure for increasing size of cylinders, as well as for high-speed engines.

In Fig. 3 is shown a curve giving the relation between indicated horsepower and speed of a vessel under actual sea conditions. Examination of a large number of Diesel-engine test results reveals the fact that the difference between the i.hp. and the b.hp. remains nearly constant within ordinary operating ranges as the load is varied. The method used below for sake of illustration yields sufficiently accurate results for purposes of estimating in figuring a relation between air-compressor capacity and b.hp. load. The percentages of loads have been taken as 30, 50, and 66 per cent,

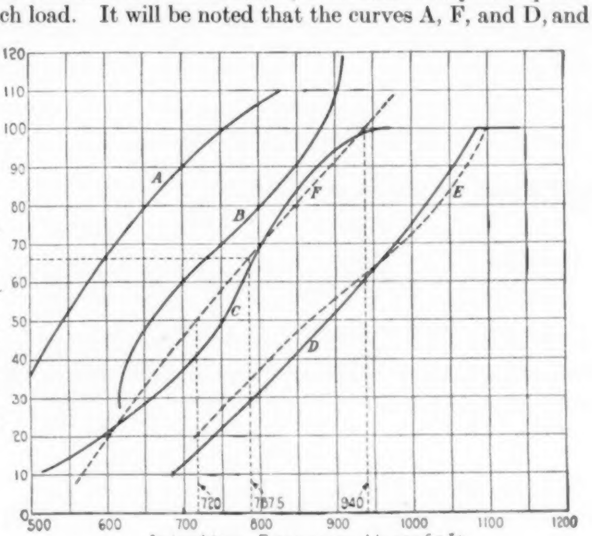

Fig. 2 Relation of Injection-Air Pressure to Percentage of Load in Horsepower

(Curve A is for a single-cylinder, 30-b.hp., stationary engine of 12-in. bore, constant speed. Curve B is for a 3-cylinder, 200-b.hp., stationary engine of 17-in. bore, constant speed. Curve C is for two 3-cylinder, 500-b.hp., stationary engines of 22-in. bore, constant speed. Curve D is of a German submarine high-speed engine fitted with automatic injection-pressure regulator. Curve E is plotted for a large engine showing most suitable pressure for a certain kind of fuel and at different loads. Curve F is based on figures given by J. W. Southern, in his recent publication, Notes and Sketches on Marine Diesel Engines.)

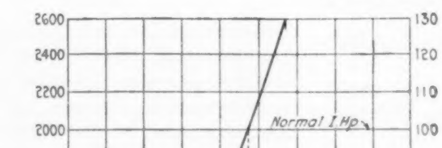

Fig. 3 Diagram Showing Relation of I.Hp. to Speed

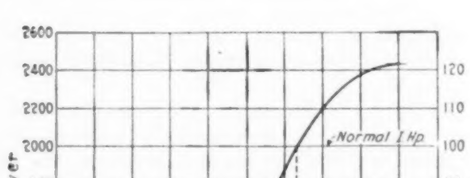

Fig. 4 Diagram Showing Relation Between Horsepower and R.p.m.

the former being the new American Bureau of Shipping rules; the latter, the old.

We have now from Figs. 2, 3, and 4 the relations between injection-air pressure, horsepower and speed, and horsepower and r.p.m. as to velocities

Load, per cent		Load per cent	
100	$V_{100} = \sqrt{940} = 30.7$	50	$V_{50} = \sqrt{720} = 27.0$
66	$V_{66} = \sqrt{790} = 28.0$	30	$V_{30} = \sqrt{637} = 25.25$

The air-compressor output decreases with decreasing revolutions of main engine (attached compressor) due to a decrease in delivery strokes for a given period. The volumetric efficiency increases, however, with decreasing speed. Neglecting the latter, the capacity will be 100, 86.5, 76, and 52.5 per cent at 100, 66, 50, and 30 per cent load, respectively. Thus we have

At 100 per cent load $1.00 \times 30.7 = 30.70$ or 100 per cent
At 66 per cent load $0.865 \times 28.0 = 24.22$ or 79 per cent
At 50 per cent load $0.760 \times 27.0 = 20.52$ or 67 per cent
At 30 per cent load $0.525 \times 25.25 = 13.26$ or 43 per cent

Finally

Load, per cent	Drop in hp., per cent	Drop in speed of vessel, per cent	Drop in capacity of air compressor, per cent
100	..	....	..
66	34	13.5	21
50	50	20.9	33
30	70	36.5	57

Putting the loads on a 100 per cent basis, the comparison or relation will reveal the uniformity or deviation, as shown below:

Compared with	Hp.	Speed	Air-compressor capacity
30 per cent taken as a 100 per cent basis			
66 per cent	48.57	37	37.82
50 per cent	71.4	57.20	58
50 per cent taken as basis			
66 per cent	68	64.6	63.6
30 per cent	140	170	172.5
66 per cent taken as basis			
50 per cent	147	155	157
30 per cent	206	270	270.1

Best uniformity in the figures (treated as index numbers), or minimum deviation, exists, as will be seen from the tabulation, on the 66 per cent and 50 per cent, with the latter as a load basis.

Single-screw vessels furnish no problems. For twin-screw vessels it will be noted that total capacity is 267, 334, and 300 per cent with an emergency capacity of 167, 167, and 100 per cent, respectively.

The best case to employ is rather hard to decide. In most cases the tendency is to have main-engine air compressors directly attached and to have the auxiliary compressor independently driven. Most direct-driven air compressors are of the slow-speed type, whereas the independent compressors are generally steam or electric driven with a higher r.p.m., resulting in smaller weight and floor space.

While there are pros and cons for high versus low r.p.m. for equal piston speeds, the higher-r.p.m. installation will have a higher number of reversals, which is really the determining factor in reciprocating machinery.

In all cases it is a matter of individual discrimination or space available that will determine the best and most economical arrangement and installation of engine-room machinery.

Capacity of Starting-Air Tanks and Auxiliary Starting-Air Compressor

The means universally adopted for starting marine Diesel engines of large power is compressed air. The storage pressure employed is usually about one-third the pressure of the injection air. In considering the storage of this air, the questions of capacity and pressure must be considered. The limits of pressure are between the lowest pressure at which the engine will start with a sufficient degree of certainty, and the pressure at which the relief valve is set. Starting by means of high-pressure compressed air, say, at 1000 lb. per sq. in., reduces the air storage but increases the dangers connected with high-pressure systems. Present-day practice is to use a pressure of about 25 atmos. or 350 lb. per sq. in. The lowest pressure at which it is possible to obtain a sure starting of an engine is about 100 to 150 lb. per sq. in., depending on the size of the cylinder bore.

It might be contended that the air storage should not be determined on a horsepower basis, but rather on a stroke, "filling-volume" basis. With due consideration to acceleration, normal speed in revolutions and stroke-bore ratio, which are factors of importance, the former method of arriving at a minimum air storage is satisfactory, although a more accurate result is obtained by using the filling-volume basis.

Nine or ten years ago the following was predicted:

In the future, the starting air storage, whether high- or low-pressure, will undoubtedly be reduced when:

1 The confidence of experience is established;

2 The regulation of the fuel is such that the chance of an engine failing to pick up on fuel immediately, due to any derangement of the fuel-injection-pump valves, or to any air in the fuel-pump passage or pipes, is minimized;

3 Some system of preliminary warming up of the engine has been adopted.

The last clause is by far the most important of the three, as due to the slow compression at a low number of revolutions a considerable amount of heat passes from the cylinder walls into the jackets, keeping the cylinder comparatively cool. Further, the expansion of the starting air in the working cylinder cools down the whole cylinder and further aggravates the difficulty of starting. The heating of the starting air prior to its introduction into the cylinders is not practicable, but the assurance that the cylinders are warm before starting requires but a short time and little effort with steam, and would go far to reduce the starting-air storage to a minimum.

The above predictions are really realized in motorships of today. A still greater discrepancy exists as to minimum starting-air

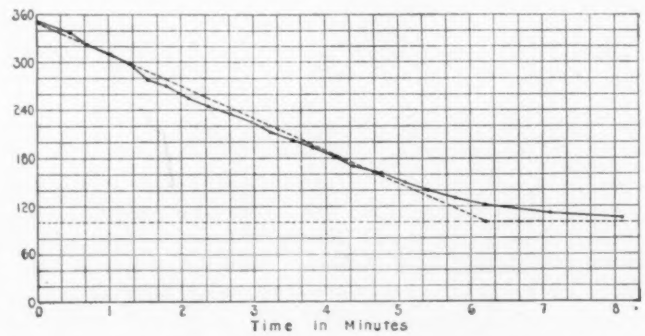

Fig. 5 Diagram Showing Relation Between Pressure, Time, and Number of Starts on Engine 5, Table 4

storage, and consequently in the capacity of the auxiliary-air maneuvering compressor.

Table 4 gives data of different types and makes of marine engines and the air storage specified by each manufacturer. It will be noted that great differences exist in the capacity of storage based on horsepower, as well as on cylinder volume. These relations are shown in Fig. 6.

A test carried out with engine 5 gave 20 starts from a tank of 250 cu. ft. capacity, without replenishing the air. The initial starting pressure was 352 lb. and the engine refused to start at a pressure lower than 100 lb., and at this pressure the time taken to start was nearly twice as much as with the initial pressure. Fig. 5 shows test results and relations between time, pressure, and the number of starts of this particular engine.

It will be noted from the table that a starting pressure of 25 atmos. is used in most marine installations, and can almost be considered as standard now. This leads to a general empirical formula giving the volume of the starting-air tanks in terms of the cylinder volume.

$$W_T = \frac{80VN}{P - 14}$$

where

W_T = volume of starting reservoirs, cu. ft.
V = cylinder volume (piston area $\times$ stroke), cu. ft.
N = number of cylinders provided with starting valves
P = starting-air pressure, atmos.

Basing the formula on the actual filling volume, $V_1 = VL$, where L is the part of stroke with starting valve open,

TABLE 4 AIR-STORAGE DATA OF 22 DIESEL-ENGINE INSTALLATIONS

1 Engine No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
2 No. of screws	2	1	2	1	2	1	2	1	1	1	1	1	2	1	2	2	2	2	2	2	2	2
3 B.hp., total	700	825	1000	1250	1500	1500	1650	2000	2000	2100	2250	2250	2250	2400	2400	2500	2640	3500	3500	3600	4800	3000
4 R.p.m.	265	135	....	....	135	110	....	96	100	....	....	....	140	....	....	....	110	....	....	115	....	110
5 No. cylinders—each engine	6	6	....	....	6	6	....	8	6	....	....	....	6	....	....	....	6	....	....	6	....	6
6 Ratio, stroke ÷ bore	1.461	1.76	....	....	1.455	1.74	....	1.772	1.80	....	....	....	1.352	....	....	....	1.495	....	....	1.551	....	1.74
7 Cyl. stroke vol. in cu. ft.	1.382	6.75	....	....	7.00	15.56	....	15.00	12	....	....	....	8.66	....	....	....	13.50	....	....	17.45	....	15.56
8 Total stoke vol. in cu. ft.	8.292	40.50	....	....	42.0	93.36	....	120.0	72	....	....	....	52	....	....	....	81.0	....	....	104.7	....	93.36
9 Per cent filling	90	85	....	....	92	87.5	....	88	....	....	....	....	88	....	....	....	88	....	....	88	....	87.5
10 Actual filling—item 7 × item 9	1.244	5.74	....	....	6.44	13.62	....	13.20	....	....	....	....	7.62	....	....	....	11.9	....	....	15.36	....	13.62
11 Total actual filling—item 8 × item 9	7.464	34.44	....	....	38.64	81.72	....	105.6	....	....	....	....	45.72	....	....	....	71.28	....	....	92.16	....	81.72
12 Normal air pressure at starting valve, atmos. abs.	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
13 Normal air pressure at starting tanks, atmos. abs.	25	25	25	35	25	25	60	25	25	75	40	48	25	25	25	75	25	25	60	25	25	25
14 Total vol. start air tank, cu. ft.	180	650	215	210	500	1150	230	755	1050	150	220	200	700	500	1130	155	1000	1520	450	1600	1175	1500
15 Ratio to cyl. vol. based on 25 atmos. pressure	10.87	16.05	5.9	4.73	5.95	12.35	13.1	6.3	14.60	8.95	4.05	4.43	6.72	2.74	9.00	6.2	6.17	6.32	4.83	7.65	4.22	8.03
16 Items 13 & 14 reduced to free air vol., cu. ft.	4500	16250	5375	7350	12500	28750	13800	18875	26250	11250	8800	9600	17500	12500	28250	11625	25000	38000	27000	40000	29375	37500
17 Min. air press. for starting, atmos. abs.	8	8	8	8	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
18 Items 14 & 17 reduced to free air volume, cu. ft.	1440	5200	1720	1680	4000	11500	2300	7550	10500	1500	2200	2000	7000	5000	11300	1550	10000	15200	4500	16000	11750	15000
19 Actual free air vol. available for starting, cu. ft.	3060	11050	3655	5670	8500	17250	11500	11325	15750	9750	6600	7600	10500	7500	16950	10075	15000	12800	22500	24000	17625	22500
20 Cu. ft. capacity air tank per b.hp. at 25 atmos.	0.257	0.788	0.215	0.235	0.333	0.767	0.334	0.378	0.525	0.214	0.156	0.170	0.312	0.208	0.470	0.186	0.378	0.434	0.308	0.444	0.244	0.500
21 Total volume calculated according to formula, cu. ft.	125	300	....	....	625	685	....	875	525	....	....	....	760	....	....	....	1200	....	....	1550	....	1360

$$W_T = \frac{80V_1N}{L(P-14)}$$

A mean value of the coefficient L is generally 0.88 or 88 per cent for 4-cycle engines, and 0.72 or 72 per cent for 2-cycle engines.

Curve C in Fig. 6 shows the above formula plotted in connection with data given in Table 4. Curves A and B are plotted from Table 4, basing the starting-air storage on horsepower or cylinder volume (curve B), respectively. Curve C could have been plotted on a horsepower basis, but it will be seen from Table 4 that a great variety in r.p.m. and stroke-bore ratio exists. Take, for example, engines 5 and 2. A difference of 75 hp. or 10 per cent exists in favor of No. 2, but this engine has a smaller cylinder volume, namely, 0.25 cu. ft., or 3.5 per cent less than No. 5, and a difference in stroke-bore ratio of 0.305 or 21 per cent larger than No. 5. The r.p.m. are the same in both cases.

This also bears out the fact that the cylinder stroke-volume per horsepower varies widely. It is only natural then, to base the starting-air volume on a cylinder-volume basis. If the storage capacity in the above case had been determined on a horsepower basis, for engine 2 we would get a volume of 342 cu. ft. instead of 300, using the data from engine 5 of course as a basis.

According to Lloyd's and the American Bureau of Shipping rules, only 12 starts, without replenishing, are required. Ample capacity is therefore found in the formula.

The capacity of the auxiliary air compressor is more or less subject to variation and depends on whether the installation is for a single-screw or twin-screw ship, also on the capacity and pressure of the starting-air reservoirs, and manner of driving them. Having more or less established the capacity of the latter, and the approximate capacity of the compressor from the rules of the classification societies, there remains to be taken into account the time taken to fill the starting-air reservoirs.

Investigating several motorships in service, it was found that the capacity of the auxiliary air compressor for starting and maneuvering was such that it was able to fill all the tanks or reservoirs in 90 min., in both single- and twin-screw vessels. It will therefore be found in many cases that when using the above time as standard, the auxiliary air-compressor capacity will be larger than the capacity called for by the classification rules.

Generally there is only one starting-air reservoir in operation at any one time, the filling of the other or others requiring only half or part time. Usually less time is taken as only few starts are required, due to the reliability in starting nowadays. Besides the auxiliary air compressor which is replenishing the air used for maneuvering, the main-engine compressor in case it is directly attached is generally opened up wide, bypassing some of its air into the starting reservoirs. It is safe, however, to base the auxiliary compressor on the time allotment given above, and the capacity W_c in cu. ft. of free air per min. is given by

$$W_c = \frac{W_TP}{90}$$

The above, while open to criticism, is an effort to minimize the capacity of starting-air tanks and auxiliary compressors, though still on the safe side, and should therefore be of some value to engineers preparing Diesel-engine installations.

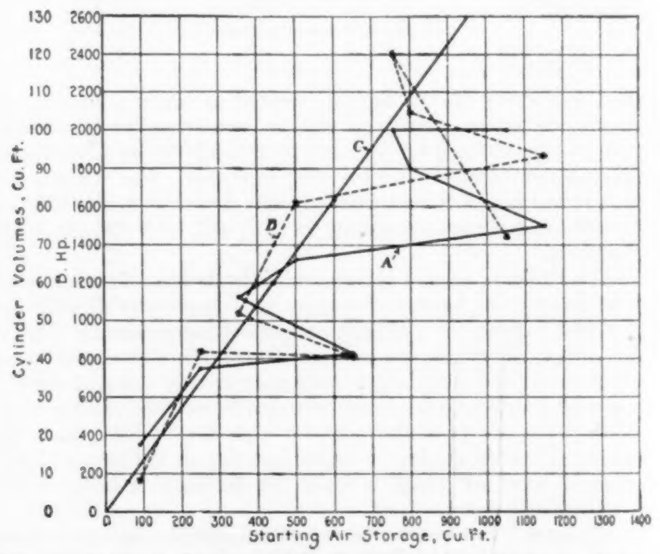

FIG. 6 DIAGRAM SHOWING RELATION BETWEEN CYLINDER VOLUME AND STARTING-AIR STORAGE VOLUME, AND BRAKE HORSEPOWER AND STARTING-AIR STORAGE VOLUME

(To be continued in the August issue)

Estimating the Power Required for Ship Propulsion

Various Methods of Estimating Propulsive Power—Preparation of Models at Washington Navy Yard Experimental Basin—The Towing Dynamometer—Calculation of Ship's Power—Determination of Propeller Efficiency—Agreement Between Model and Ship Tests

By E. L. GAYHART,[1] WASHINGTON, D. C.

ESTIMATING the power required for ship propulsion is a problem entirely different in nature from the problems encountered in general engineering experience, and in its solution certain highly specialized methods have been developed. Several methods have been successively evolved for making such estimates, all of them being based directly or indirectly upon comparison with the known performance of some previous ship or model.

Successive Methods of Estimating Propulsive Power

In general, the resistance of a ship may be resolved into two components, the skin friction and the residuary resistance, the latter comprising three elements, the most important of which is the wave-making resistance. For relatively slow speeds the frictional resistance forms most of the total resistance of the ship. This frictional resistance varies with the speed at a rate somewhat less than the square, the exponent being approximately 1.83. In the first attempt to estimate the power for a new design by comparison with a previous design generally similar, it was assumed that the resistance would be proportional to the wetted surface and to the square of the speed. Further, the assumption was made that the wetted surface is proportional to the two-thirds power of the displacement. The power of a ship might then be expressed by the simple equation,

$$I = \frac{D^{2/3}V^3}{C}$$

where I is the indicated horsepower, D the displacement, V the speed, and C is a constant known as the Admiralty coefficient and derived from the analysis of the trials of previous ships of similar form.

This method gave a fair approximation so long as the speed was low and the prototype similar in form. However, it contains three erroneous assumptions, since the power required does not vary as the cube of the speed, the efficiency of the power plant is not constant, and the wetted surface is not proportional to the two-thirds power of the displacement except for geometrically similar forms.

The next method to gain favor was one brought forward by Dr. A. C. Kirk, in which the immersed volume of the ship was replaced by approximately equivalent wedges and parallelopipeds in order to simplify the calculation of the immersed area. He then estimated the power by the equation

$$I = \frac{kSV^3}{10{,}000}$$

where S is the wetted surface obtained by his method of analysis, and where the constant k varies from 4 for fine ships to 6 for short and broad ships. The only improvement over the previous method lay in the closer approximation to the wetted surface.

The next method, based on the theory of mechanical similitude, was first successfully applied some fifty years ago by Wm. Froude, and its formulation is known as Froude's law of comparison. Froude's law states that at corresponding speeds the resistances of ships of similar form are in the ratio of their displacements. This law is strictly applicable to the residuary resistance only, not to the total resistance. Corresponding speeds are defined as speeds in the ratio of the square roots of the lengths of the ships. This theory, based on mechanical similitude, is usually demonstrated from consideration of the dimensions of the various quantities involved in terms of the fundamental units of length, mass, and time. An extension of the law of comparison to a consideration of power yields the relation between ships of similar form that at corresponding speeds their powers are in the ratio of the $^7/_6$ power of their displacements.

The work for which Froude is most celebrated is his development of a method whereby the data obtained by towing models of ships in a tank or basin may be used with accuracy for estimating the resistance of ships, and his demonstration of the validity of this method by comparing the model prediction with the data obtained from towing a full-sized ship, the *Greyhound*. Briefly, his method

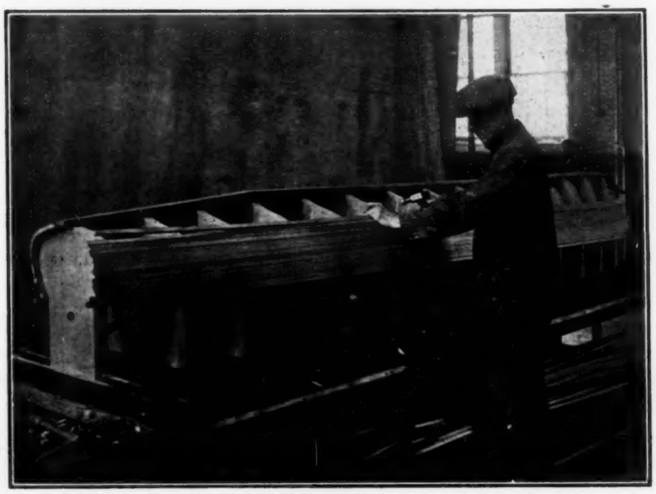

Fig. 1 Wooden Molds for Model Construction

consists in measuring the resistance of a model, computing the skin friction of the model, and deducting this skin friction from the measured resistance. The remainder, called the residuary resistance, follows the law of comparison, and is increased in the ratio of the cube of the linear ratio of ship to model. To the ship residuary resistance so obtained is added the computed ship frictional resistance, and from this resulting ship total resistance the power is computed.

The frictional resistance, which is proportional to the wetted surface, to the speed raised to a decimal power approximating 1.83, and further to a coefficient of friction found to vary with the length of the surface, is computed by a formula which includes these three variables and has the form

$$R_f = fSV^{1.83}$$

Preparation of Basin Model

Further discussion of the model-tank method may well be preceded by description of the experimental model basin at the Washington Navy Yard, and the particular methods and models there employed.

The models at the Washington Basin are generally made of California redwood. In the manufacture of a model, the shape of a ship is represented by plans known as "lines," the most important of which is the body plan, a drawing upon which are superposed the contour lines or sections cut by transverse vertical planes spaced along the longitudinal axis. Since the standard model is 20 ft. long, irrespective of the ship length, a pantograph is used to convert the lines as received to the model scale. From

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the model lines, wooden molds are made of the shape of the transverse sections. These molds are set up on a bedplate at the proper stations and battens nailed over them, making a temporary form of the shape of the ship (Fig. 1). Meanwhile the rough blank from which the model is to be cut has been glued together and placed on the bed of a cutting machine (Fig. 2). The temporary form is placed on this machine in its correct position with respect to the model. The cutting machine consists of a pantograph frame carrying a revolving cutter and a roller in register, so to speak, with this cutter. The roller is passed over the temporary form, causing the cutter to duplicate this profile on the model. The frame may be moved longitudinally with respect to the model, permitting the entire surface of the form and model to be gone over with transverse cuts. The model is roughed out on this machine to within $^1/_8$ in. of the finished surface.

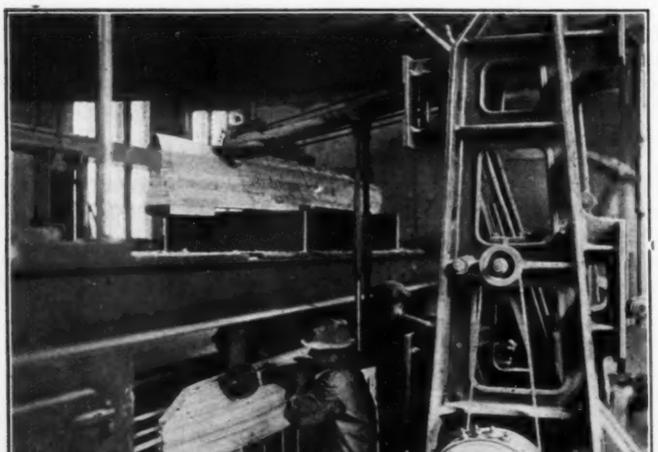


Fig. 2 Rough Blank on Bed of Cutting Machine with Temporary Form in Correct Position with Respect to the Model

The temporary form is next dismantled and the molds set up on another cutting machine where they are used as templets for a cutter which makes accurate cuts at the several stations down to the finished surface. Modelmakers using hand tools then finish the model down to the surface outlined by the transverse machine cuts.

The next step in the manufacturing process is to paint the model with a coat of linseed oil, two coats of oil paint, a coat of flat gray, and a coat of quick-drying varnish.

After painting, the model is placed on a table equipped with means for measuring the offsets or coördinates of the several stations. A set of lines prepared from these offsets is used for the calculations of the wetted surface of the model, and of its displacement.

After measurement, the model is ready for towing. The immediate preparation for towing consists in fitting towing fixtures and ballasting the model, since it is necessary to float the model at a water line corresponding to the water line of the ship. It is the Model Basin practice to use the weight of the model as the criterion for comparison rather than its draft, and ballast as necessary is added to bring the total weight up to an amount proportional to the ship's displacement. This ballast is adjusted in position to bring the model on an even keel or to give the model a definite trim by the bow or stern, as is sometimes done to study the effect upon the ship's resistance of changes in the distribution of her loading.

The Towing Dynamometer

The towing carriage (Fig. 3) is a massive structure rolling on trucks along a double-rail track on the two sides of the basin; its total weight is about 80,000 lb., which provides sufficient inertia to suppress tendencies for sudden changes in speed. The measuring apparatus is located on the axis of the basin. At each of the four corners of the carriage there is a 50-hp. separately excited motor geared directly to the adjacent truck wheels, with six sets of overhead trolleys.

The Ward Leonard system of speed control is used for the propulsion of the carriage and also furnishes the means of braking. Emergency mechanical braking is also provided with hydraulic pressure acting upon a system of pistons which press together two parallel bars anchored along the track on each side of the basin at the end of the run. Plates projecting down from the carriage slide into the space between these bars, and the friction is sufficient to stop the carriage from 8 knots speed in about ten feet of run.

The principal function of the towing carriage is to tow a model at a uniform speed and measure the resistance in pounds offered by the water to the passage of the model. The means by which the resistance is measured is a balance having three arms of equal length with its axis transverse to the basin (Fig. 4). The two horizontal arms carry scale pans. The vertical arm projecting down from the pivot carries the towing link to which the model is coupled. A dashpot serves to damp the oscillations of the balance. The model is towed at progressively higher speeds, any one run being at a constant speed. Weights are placed on the rear scale pan equal to the anticipated resistance of the model for the speed at which it is intended to make the run. A stand on the operating platform (Fig. 5) carries a drum having its axis in the direction of travel and driven at a speed proportional to the speed of the carriage. A pen actuated by a chronometer records seconds on the record carried by the drum and, by an appropriate scale, the speed of the carriage in knots. A movable pointer attached to the balance traces on the record the deflections of the balance, while a fixed pointer traces a line which represents the position of equilibrium for the balance. The displacement of the line traced by the moving pointer with reference to the fixed line gives a measure of the correction to be applied to the weights on the pan to give the true value of the resistance.

Fig. 3 The Towing Carriage

The model is towed at successive speeds, and the records from these runs are plotted with model speeds as abscissas and pounds resistance as ordinates (Fig. 6).

Methods of Calculating Ship's Power

As a preliminary, the displacement ratio of ship to model, which is equal to the cube of the length ratio, is determined. A correction for the density of salt water is made by a further factor of 1.024. The value of the square root of the length ratio gives the ratio of corresponding speeds of ship and model. The several

factors for converting model residuary resistance to ship residuary power are combined into a single factor a, where

$$a = 1.024\ (L/l)^3 \times 0.0030707 \times \sqrt{L/l}$$

the constant 0.0030707 being a factor to convert units of pounds and knots into horsepower. The residuary effective horsepower (e.hp.$_r$) of the ship is then derived directly from the model residuary resistance by the equation

$$\text{e.hp.}_r = avr_r$$

in which a is the factor just described, v the speed of the model, and r_r the model residuary resistance. The residuary resistance of the model is derived as previously described by subtracting from the total resistance the computed frictional resistance. The frictional component of the ship's e.hp. is then computed directly from this value of the wetted surface, and the sum of the two powers yields the estimated total e.hp. for the ship.

Distinction Between Effective Horsepower and Shaft Horsepower

The effective horsepower, however, is only the net power that would be required to tow the ship, and the ratio of effective power to shaft power is ordinarily only about 0.60. This factor, known as the propulsive coefficient or propulsive efficiency, is the

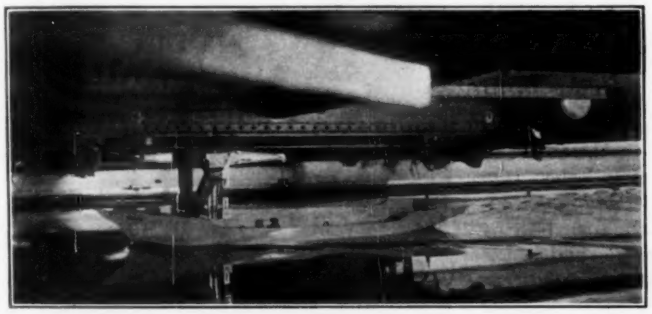


Fig. 4 Balance for Measuring Resistance

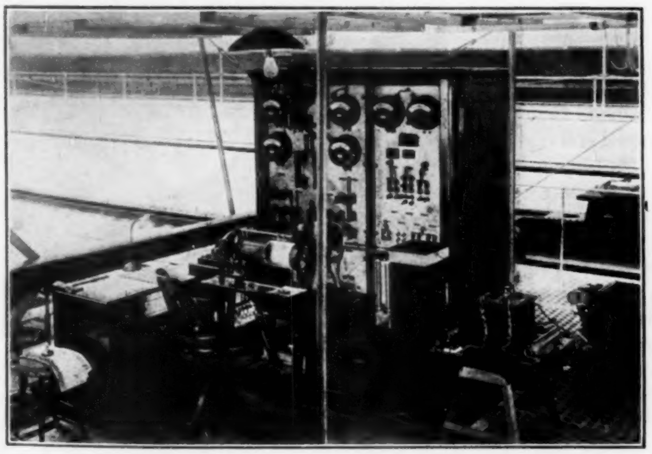


Fig. 5 Stand on Operating Platform

combined product of the propeller efficiency and the hull efficiency. The propeller efficiency is of course the ratio of thrust power delivered by the propeller to the torque power put into it. The hull efficiency represents the influence of the hull upon the performance of the propeller and contains two elements, one the wake gain which the propeller derives from working in the wake of the ship, and the other the thrust deduction, which is the augmentation in the ship's resistance consequent upon the reduction in water pressure acting on the ship in the vicinity of the propeller. These two influences act in opposition, and since for ships of usual form their effects are about equal, the hull efficiency is not ordinarily far from unity.

Determination of Propeller Efficiency

Within the past few years methods have been developed whereby the shaft horsepower (s.hp.) may be estimated from the performance of models by determination of the efficiency of model propellers.

The model propellers are conveniently made by casting the blades upon a brass hub. The alloy used for the blades has a low melting point, which permits the use of wooden molds. The molds are made by machining two blocks of hardwood to a helicoidal surface having the pitch of the propeller. One of these surfaces forms the driving face, while the back of the blade is hollowed out from the opposite block. A fixture holds these blocks in correct position

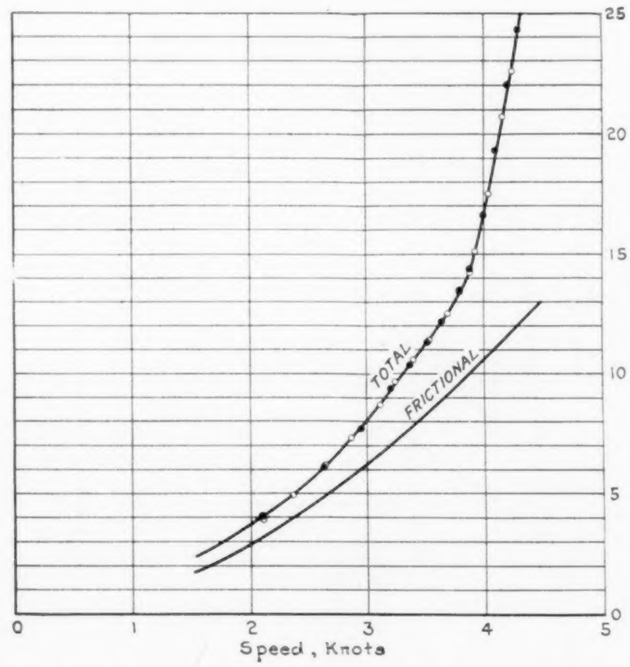


Fig. 6 Curves of Model Resistance at Varying Speeds

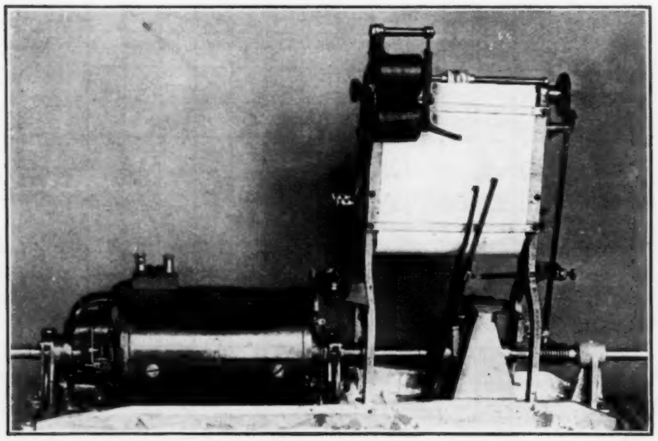


Fig. 7 Recording Dynamometer for Propeller Tests

relative to the hub. By suitable indexing it is possible to cast the three or four blades about the hub by the use of one mold.

The general methods of comparison between ships and models apply equally well to comparisons between large propellers and model propellers. But considering the total resistance of the ship and of the model, it is found that by reason of the failure of the frictional resistance to follow the law of comparison, the total resistance of the model is larger than would be obtained by reducing the ship resistance by the cube of the linear ratio. In other words, the model is relatively harder to drive than the ship. Such a situation would demand greater thrust from, and greater slip with, the model propeller than prevails for the ship propeller, and would disturb the wake and the thrust deduction. The direct total propulsion of the model by its own propellers would not yield correct results. This situation, however, is taken care of in self-propulsion experiments at the Model Basin by a method that will shortly be described.

In the apparatus for self-propulsion the propellers are driven by small electric motors constructed as recording dynamometers (Fig. 7). The shaft drives the paper feed at a speed proportional to the revolutions. Prick marks are punched in the paper for every 96 revolutions, while a time pen traces a record of seconds. These two indications yield the r.p.m. A pen attached to a spring-mounted thrust bearing traces a record of the propeller thrust, while a spring and pen connected with the roller-mounted field frame of the motor trace a record of the reaction between the field and armature, which is a measure of the torque without deduction for bearing and commutator friction.

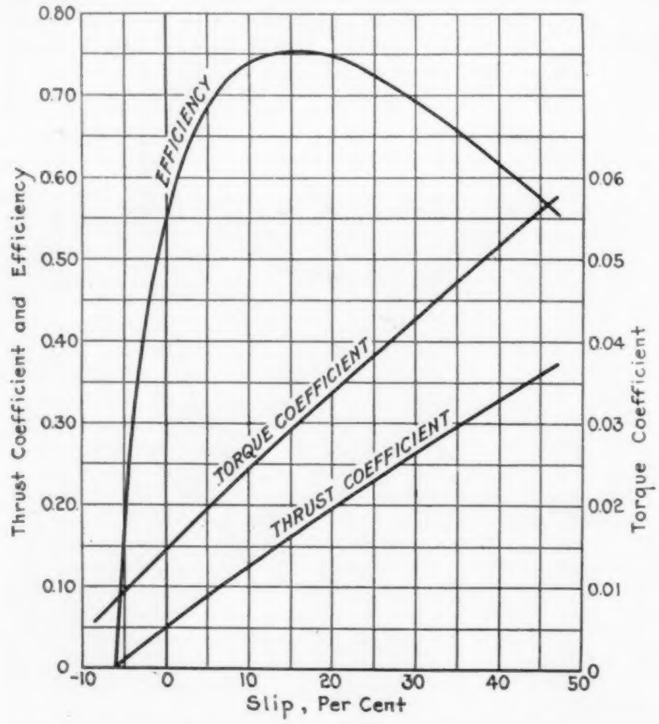


Fig. 8 Propeller Efficiency, Thrust, and Torque Coefficients (U. S. S. *New Mexico*. Propeller diameter, 13 ft. 5 in.; pitch, 15 ft. 2 in.)

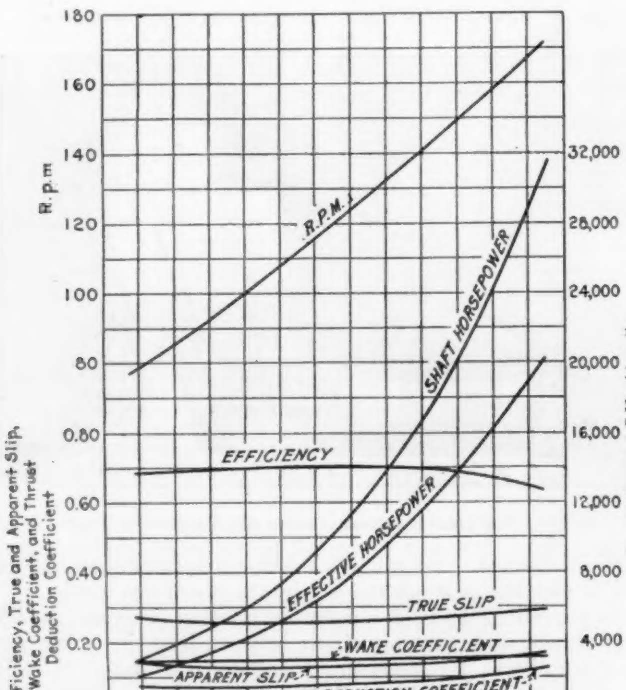


Fig. 10 Curves of S.Hp., R.P.M., E.Hp., Propulsive Efficiency, True Slip, Apparent Slip, Wake Coefficient, and Thrust, Deduction Coefficient (U. S. S. *New Mexico*.)

The Model Basin procedure first characterizes the propeller. The propeller is driven on a long shaft projecting from the bow of a boat-shaped form in which the isolation of the propeller is such that it is working in undisturbed water. Under such conditions the speed of the carriage is directly the speed of advance of the propeller without correction for wake. The carriage makes runs at a constant speed, three knots, but with varying revolutions for the several runs. The effect is to operate the propeller over a range of real slip. From the data obtained a curve of propeller efficiency (Fig. 8) is plotted, based upon real slip. Curves are also obtained for non-dimensional thrust and torque functions for the propeller, based upon real slip.

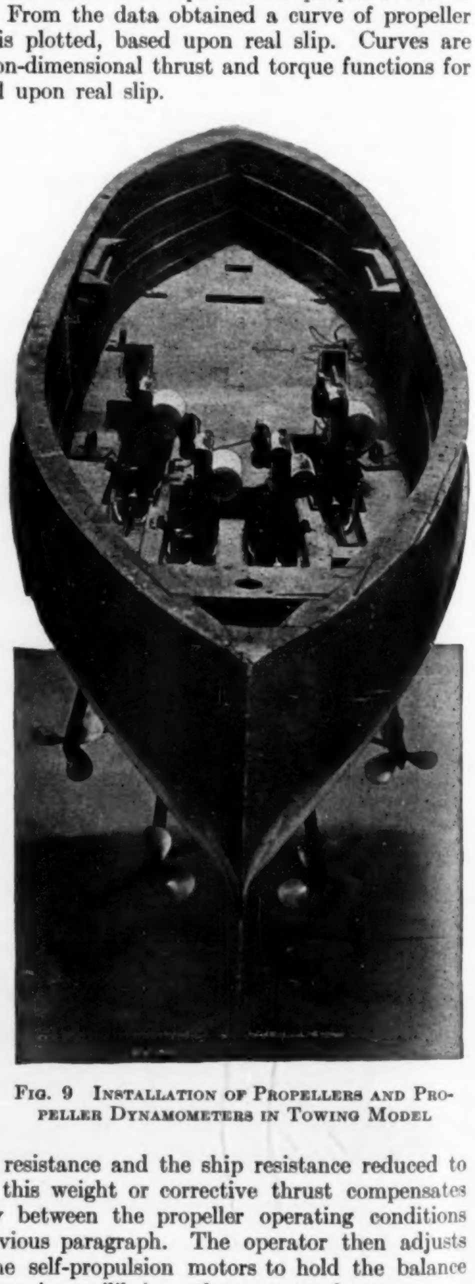


Fig. 9 Installation of Propellers and Propeller Dynamometers in Towing Model

With this knowledge of the propeller characteristics, the self-propulsion test may proceed. Referring to Fig. 9, the motors are installed in the model, shafting fitted, dummy hubs mounted of weight equal to the propeller weight, and runs made with the model to obtain the tare corrections to apply for bearing friction and for the fore-and-aft component of shafting weight in case the model changes trim. The propellers are then fitted to the model. It should be explained that the model is connected to the towing dynamometer as for towing tests. Upon the scale pan of the towing dynamometer a weight is placed equal to the difference, at the particular speed about to be run, between the model resistance and the ship resistance reduced to scale. The use of this weight or corrective thrust compensates for the discrepancy between the propeller operating conditions mentioned in a previous paragraph. The operator then adjusts the rheostat for the self-propulsion motors to hold the balance in equilibrium. When in equilibrium, the operator knows—

1 That the model speed equals the carriage speed, which speed is obtained from the carriage chronograph
2 That the carriage is relieving the propellers of the excess of model resistance over ship resistance to scale, or conversely, that the propeller thrust is correctly to scale;

from which it follows from the theory of similitude that, the thrust being to scale,

1 The slip is the same as the slip in the ship
2 The thrust deduction and wake are the same as for the ship, and

3 The torque and revolutions are to scale; or, in other words, that the ship and model are dynamically similar.

The model is thus propelled over the entire speed range. The dynamometer and chronograph records are then reduced to terms of speed, revolutions, torque, and thrust. A comparison between thrust and model resistance yields the thrust deduction. The linear ratio of ship to model is reduced to a constant, which, multiplied into the product of model revolutions and torque, yields the shaft horsepower of the ship. The revolutions for the ship are inversely proportional to the square root of the linear ratio. The propulsive efficiency is ratio of the e.hp. to s.hp. obtained above. The real slip is obtained from the characteristic curves for the propeller, entering these curves with the torque and thrust coefficients obtained from the propeller performance behind the model. The apparent slip is obtained by comparison of model speed with the product of revolutions and propeller pitch. The comparison of real (or true) and apparent slips yields the wake coefficient. The hull efficiency is given by the ratio of $(1 - t)/(1 - w)$, where t and w are the thrust and wake coefficients.

The results of the self-propulsion tests are worked up in the form of a set of curves for the ship (Fig. 10) in which there appear the following curves plotted against speed of the ship: namely, shaft horsepower, revolutions, effective horsepower, propulsive efficiency, true slip, apparent slip, wake coefficient, and thrust-deduction coefficient.

Agreement Between Model and Ship Test

The procedure described above has been in use at the Experimental Model Basin since 1916. Since its inception opportunity has been afforded for self-propulsion experiments on all of the recent vessels of the Navy with comparison between the estimated shaft horsepower and the actual shaft horsepower from trial-trip records, with a very satisfactory agreement. The agreement, in general, is within the precision of the torsion dynamometers or other instruments used on the ships for the measurement of their power. Where there have been discrepancies, it has been possible to recognize possible causes for them, such as an unusual form for the vessel or conditions of operation that would induce cavitation in the propeller.

The Selection of Proper Material for Tool Manufacture

By J. B. Mudge,[1] Chicago, Ill.

THERE is perhaps no other question among the makers and users of tool steel on which there is more discussion and less general agreement than this: namely, "What is the best steel for making tools?"

"Shall cutting tools be made from high-speed or carbon tool steel? If from carbon steel, shall a small amount of chromium be added to increase the depth of hardness penetration? If from high-speed steel, shall the cutting tools be made of the 18-4-1 type of H. S. S., the 14-4-2 type, or with or without Co, Ni, Ur, Mo, etc.?"

"Shall blanking punches and dies be made of water-hardening carbon tool steel, or of an alloy steel that hardens in oil to blanking-die hardness, or of high-speed steel that hardens when quenched in molten salt at 1100 deg. fahr. and subsequently drawn at 1100 deg. fahr.?"

Questions of these types are too numerous to mention, and the number of varied answers depends on how many different persons are asked.

The author doubts very much whether there is any "best" steel for all jobs. The nearest approach to an all-purpose steel is the high-speed, but there are so many factors involved in a test for the determination of a "best" steel for any one job, that the results are open to question.

Before describing work done in the selection of steel for tools, just a word about tool-steel specifications. A specification that merely specifies chemical analysis and tolerances with stereotyped phrases which are in themselves more or less meaningless, is of little advantage to either the user or the supplier. But a specification that maintains reasonable manufacturing variations of analysis and tolerances, that gives a workable range of physicals; one that tells the manufacturer what is wanted and also tells what in the buyer's opinion, based on experience in his own shop (not some one else's), will best meet these requirements. This specification should also be a help to the steel manufacturer, as it will enable him to visualize the needs of the buyer and grade his material accordingly. Whatever the merits or demerits of tool-steel specications may be, the author's concern has found them very desirable.

Selection of Tool Steels

There are several items to consider in selecting raw material such as tool steels: namely,

1 Deal with a reputable concern that has a well-arranged mill whose equipment, trained personnel, and general business policy merit confidence. In the manufacture of quality products it is imperative that the material used should be closely controlled, and the use of a uniform base from a known source is good insurance when selecting tool steels.

2 Establish means for identifying the types of tool steels. This involves purchase specifications, the advisability of which has been discussed, and a classification scheme for the various types of steels.

3 Set up in the plant the routine for raw-material inspection so as to be reasonably sure that the concern is getting what it pays for.

This immediately raises the question as to how much or how little inspection can be justified by the costs involved. It costs money to inspect steel; it also costs money to build tools from seamy or defective steel. There is a return from the money spent for inspection, but the money spent in building tools from defective steel is not infrequently a total loss, since they very often never get any further than the heat-treating department, and when they do slip by and get into the shop, they fail all too soon as a producing medium.

For a small plant that cannot afford a technical staff, microscopic equipment, etc., the author believes the minimum inspection should be:

A—Visual. This requires considerable experience, but should be used by all in the detection of seams, slivers, etc. To the best of the author's knowledge, this forms the major part of all mill inspections other than heat analysis. In some cases it is supplemented by the fracture of an annealed bar, and in some cases by that of a hardened bar.

B—Macroscopic, Hot-Acid Etch Test. The author believes that more information can be obtained by this test at less cost than any other he knows of, that is, for the detection of manufacturing defects. It is not difficult to make and can be carried out by men with even a slight experience in the matter of handling steels. It shows decarburization, seams, scabs, flakes, slag, slivers, and inhomogeneity in general.

C—Brinell Test. To show uniformity and degree of anneal.

All three of these tests are cheaply and quickly made, and show up marked variations and defective conditions which are a positive basis for rejection of undesirable material.

In the larger companies these tests are supplemented by the microscope, which is probably the best means there is of evaluating

[1] Metallurgist, Hawthorne Works, Western Electric Company.

Presented at a joint meeting of the Chicago Section of The American Society of Mechanical Engineers and the Western Society of Engineers, Chicago, March 24, 1926. Abridged.

the condition of the steel, i.e., the process heat treatment, etc.

It will be probably noticed that no reference has been made to chemical composition in inspection. Other than touching the bar to a wheel and observing the spark to see that machine steel or high-speed steel has not been mixed with the carbon steel, the analysis inspection should be limited to a very small percentage of the whole.

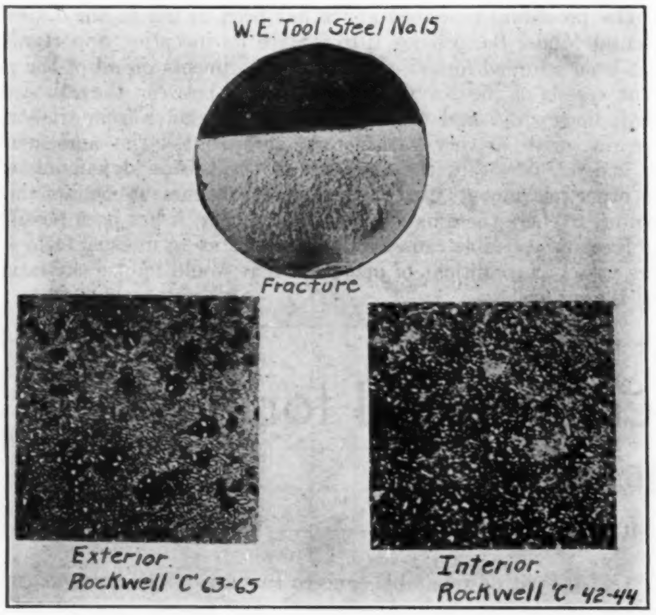


Fig. 1 Fracture, Microstructure, and Rockwell Hardness Values of a Carbon Tool Steel

[C, 1.00 (1.09); Mn, 0.25 (0.35); Si, 0.15 (0.25). Brinell number (annealed), 170 to 190.]

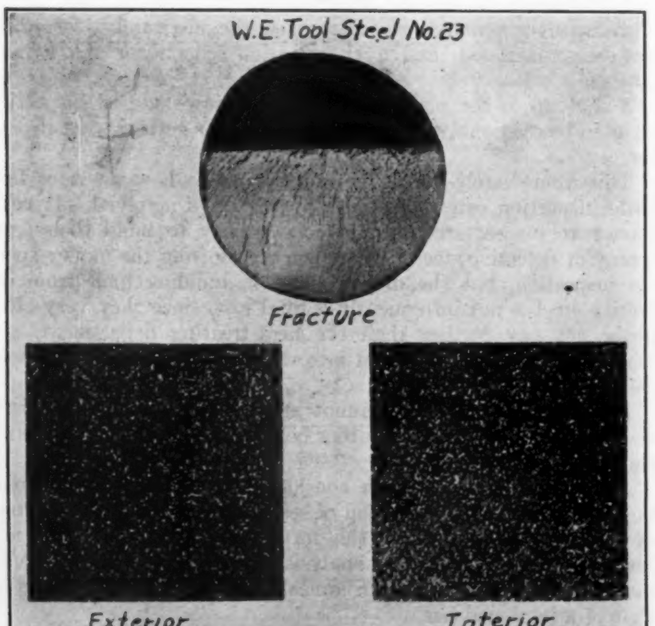


Fig. 2 Fracture, Microstructure, and Rockwell Hardness Values of an Alloy Tool Steel

[C, 1.25 (1.40); Mn, 0.25 (0.35); S and P (0.025); Si, 0.15 (0.50); Cr, 0.15 (0.80); W, 3.50 (4.40); Va, optional, Brinell number (annealed): max., 235.]

Perhaps an occasional check of the carbon content to see that the material is running consistent with the practice of the mill from which it was obtained, should be sufficient. In the case of alloy steels a check on the main alloying elements should suffice.

The cost of inspection is more or less determined by the amount of material inspected, and, if the chemical analysis is held to a minimum, should not run very high.

There are certain classes of material that require 100 per cent inspection, for example, a piece of steel that is to be used for an expensive blanking punch or die, expensive high-speed form cutters, milling cutters, etc. Others, however, may require not more than 10 per cent inspection, e.g., drill rod, and small bar stock in general, for making what are in reality machine parts and not tools.

In general, it would be unwise to spend from one to fifteen hundred dollars working up a piece of steel into a die, without taking reasonable precautions to ascertain that the steel was desirable for that work.

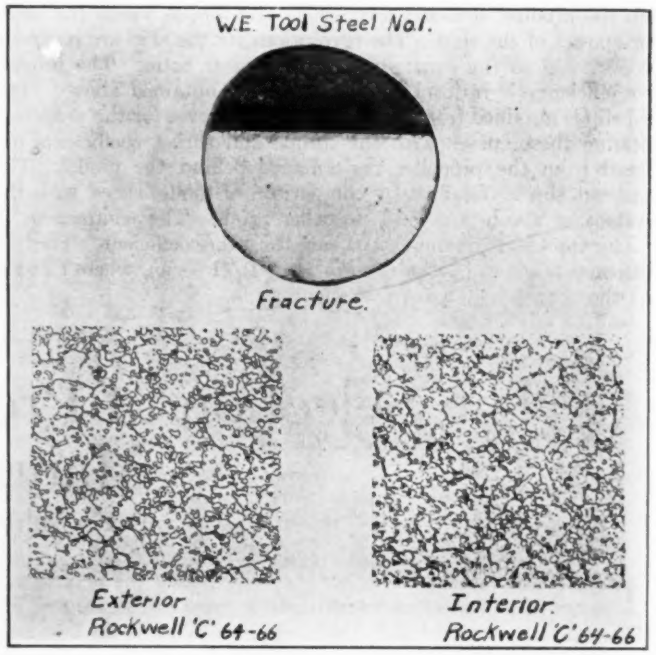


Fig 3 Fracture, Microstructure, and Rockwell Hardness Values of a High-Speed Steel

[C, 0.65 (0.75); Mn, 0.15 (0.40); P and S, (0.035); Si, 0.15 (0.35); Cr, 3.50 (4.25); W, 17.0 (19.0); Va, 0.80 (1.10). Brinell number (annealed): max., 248; desired, 230.]

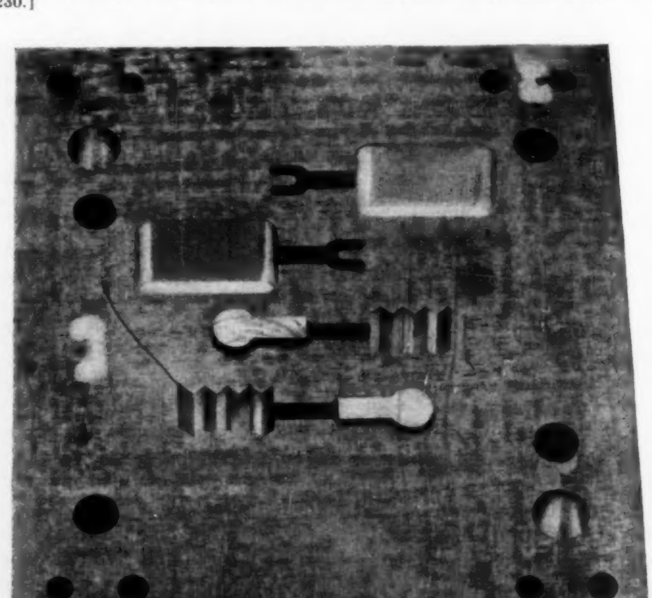


Fig. 4 Showing Die That Cracked Because of Intricacy of Design, Lack of Fillets, Etc.

4 Assuming now that a uniform high-grade material is being received, the next item of importance is the hardening room. Whereas no amount of scientific heat treatment will produce good

tools from defective raw material, poor heat treatment will ruin the very best of steel.

The human element comes first. Regardless of how much modern scientific equipment a man has, he can still do poor work. Regardless of how much experience a man has had and how excellent a treater he may be, he is a detriment to the organization if he resists improved equipment and methods.

Other than the human element, the author considers that the most important feature in a hardening room is automatic temperature control. A furnace under automatic control, however, must still be used with care and judgment.

The arrangement and number of varying types of furnaces, the quenching solutions employed and their general arrangement throughout the hardening room, are in each case determined by the work to be done.

Production hardening is a quantity affair, and process specifications for any one type of work can be closely drawn.

Testing equipment is available for measuring ultimate strength, yield point, proportional limit, elongation and reduction, impact values, fatigue values, etc. Tools, however, i.e., cutting tools, blanking tools, swaging tools, shearing tools, are used in a condition which prohibits tests of this type. Test bars made up and treated to simulate blanking-punch-and-die conditions give results that are practically valueless since steel in the hardened condition has no elongation or reduction to speak of, and the proportional limit and ultimate strength vary so as to be useless as standards of measurement.

That leaves us with either the file as a means of detecting hardness or one of the hardness-testing machines—Brinell, Rockwell, or scleroscope. Each of these has its sphere of application, and use is found for all of them. In testing hardened tools where the minimum distortion or marring of surface is desired and rapid application of method is necessary the author's company prefers the Rockwell, and inspects its hardened tools 100 per cent.

T.S. NO.	TYPE	SPEC NO.	CHEMICAL COMPOSITION	C	MN	S	P	SI	NI	CR	W	VA	CO	MO	PAINT COLOR	BRINELL NO. ANN'L'D	HEAT TREATMENT: ANNEALING	NORMALIZING	SPHEROIDIZING	HARDENING: METHOD	QUENCHING TEMPERATURE	QUENCH MED.	DRAW MED.	APPLICATIONS IN W.E. CO.	REMARKS
21			MIN																						(1) TEMPERATURE OF QUENCHING MEDIUM SHOULD BE ABOUT 85°F. (2) THE DRAWING TEMPERATURE IN EACH CASE WILL DEPEND ON THE USE TO WHICH THE TOOL IS PUT. (3) 1575°F IS RECOMMENDED FOR NON-DISTORTION.
			MAX																						
22			MIN																						
			MAX																						
23	HARD TURN HIGH-C LOW-W	58108	MIN	1.25	.25			.15		.15	[illegible]	OPT			RED AND BROWN	MAX 235	1400°F TO 1450°F	1600°F TO 1650°F	1290°F TO 1325°F	OPEN FIRE	1500°F TO 1525°F	BRINE OR WATER (1)	OIL OR AIR (2)	TOOLS FOR TURNING BRASS, TINSEL ROLLS, DRAWING DIES, SWAGING DIES FOR LUG HOLDERS, SCRAPING TOOLS,	
			MAX	1.40	.35	.025	.025	.50		.50	[illegible]	OPT								SALT BATH	"	" (1)	" (2)		
24	NON SHRINKING OR OIL HARDENING	58109	MIN	.80	1.00			.35				OPT			WHITE	MAX 212	"	1475°F TO 1525°F	"	OPEN FIRE	"	OIL	" (2)	BLANKING PUNCHES AND DIES, THREAD ROLLING DIES, MASTER GUAGES, THREAD GAUGES, CHASERS, TAPS FOR GUAGES	
			MAX	1.00	1.35	.025	.025	.50				OPT								SALT BATH	"	"	"		
25	"	"	MIN	.80	1.10			.20		.40	.40				WHITE AND BLACK	MAX 212	"	"	"	OPEN FIRE	"	"	"		
			MAX	.95	1.30	.025	.025	.35		.60	.60									SALT BATH	"	"	"		
26	"	"	MIN	.70	.13			.20		1.45	.35				WHITE AND RED	"	"	1475°F TO 1500°F	"	OPEN FIRE	"	"	"		
			MAX	.90	.25	.025	.025	.30		1.60	.50									SALT BATH	"	"	"		
27	"	"	MIN	1.05	.20			.10		.25	1.00	OPT			WHITE AND GREEN	"	"	1600°F TO 1750°F	"	OPEN FIRE	1550°F TO 1650°F (3)	"	"		
			MAX	1.25	.50	.025	.025	.50		1.00	1.75	OPT								SALT BATH	"	"	"		
28	WIRE DIE	58110	MIN	2.10	.20			.25		12.00		OPT			RED AND GREEN	MAX 248	1550°F TO 1600°F		"	OPEN FIRE	1600°F TO 2200°F	OIL	OIL OR AIR	BLANKING PUNCHES AND DIES, WIRE DRAWING DIES, CARBON BUTTON TOOLS, CERAMIC MOULDS	
			MAX	2.60	.30	.025	.025	.50		13.00		OPT								SALT BATH	"	"	"		
29			MIN																						
30																									

FIG. 5 TYPE OF TOOL-STEEL CLASSIFICATION CHART EMPLOYED BY THE WESTERN ELECTRIC CO.; SERVES TO IDENTIFY VARIOUS STEELS AND ASSISTS IN PREPARING PURCHASE SPECIFICATIONS

Tool hardening being a quality or job-lot proposition, there are no general rules.

The author's concern has found it necessary to install all types of furnaces and quenching baths, and uses practically all of the present-day methods in its hardening department which is now in the process of installation.

Furnace design may be dismissed with the brief statement that practically all of the gas and electric furnaces now on the market are acceptable when properly applied. Other than insisting on automatic temperature control and on the fact that the nearer the quenching tanks are to the furnaces the better, the author hesitates to lay down any hard-and-fast rules.

THE SELECTION OF THE STEEL FOR THE JOB

Assuming now a supply of a uniform high-grade steel and a modern heat-treating department, what can be said for the type of steels to be used in making up the various tools.

All steels (carbon and alloy) in the dead-soft annealed condition give physical results that are practically similar, depending on the carbon content. In general, they run from 60,000 to 100,000 lbs. per sq. in. T.S. The distinguishing characteristic is the resistance to shock, and it is only when heat treatment is resorted to that the inherent value of the alloying elements is brought out.

In general,

Carbon affects strength, toughness, hardness, etc., and is a class by itself as an alloying element

Nickel is a toughening element, increasing the resistance to shock

Chromium is a hardening element

Vanadium is a hardening and toughening element

Tungsten in small percentages increases hardness, and in large percentages (high-speed steel) confers the property of red-hardness.

Figs. 1, 2, and 3 show the fracture, microstructure, and hardness values of three type steels: carbon, alloy, and high-speed. Theoretically, the manner in which alloying elements are effective is a debatable point, but in general they seem to affect the transition point so that the critical quenching speed (the rate of speed with which the steel passes through the critical point) permits a mild quench (oil) to give the same or improved results with alloy steels that a drastic quench (brine) gives with the straight carbon steel.

This brings us to the so-called non-shrinking steels. Practically all of the types now on the market harden in oil. Reasoning by analogy, a steel that will harden by cooling in air, or even better, in molten salt or lead at 1050 deg. fahr., will show even less distortion. There is such a steel, i.e., high-speed steel, but the author wishes to point out that there is no such thing as a non-distorting steel. The alternate heating and cooling of steel distorts it by reason of changes occurring within the metal itself, the ultimate result being the summation of several factors, namely, size, design, change of section, rate of heating, length of time at temperature, previous conditioning of the metal, and more important than any other, how the die is plunged into the quenching bath.

It is not to be wondered at that hardened dies of the intricate design shown in Fig. 4 distort and sometimes crack, in fact it would be miraculous if they did not. It is practically impossible to cool a piece of steel with varying cross-sectional areas such as this has at the same rate of speed, and the best solution is to keep the various sections as uniform as possible and to allow generous fillets whenever and wherever possible.

When and where to use carbon, special alloy, or high-speed steel depends entirely on the job to be performed.

1 In cutting tools, if the speed of the operation raises the temperature of the tool above that which that particular type of steel can be drawn to and still retain its desired hardness, then a high-speed steel is absolutely essential (excepting when machining hard rubber).

2 There are jobs, however, where in addition to cutting qualities a high shock or impact value is necessary. Jobs of this kind must be operated at slower speeds, and here carbon tool steel is preferable, because of its soft, tough core. (Twist drills, reamers, taps, etc.)

3 For blanking punches and dies on jobs such as nickel silver, carbon-tool-steel sheet, and silicon-steel sheet, in general the author favors high-speed steel over carbon tool steel (no red-hardness involved), as it has been found that this gives a longer life. For the general run of soft steels, brass, copper, etc., the economies to be effected by changing from carbon to high-speed steel are still a debatable subject. His company is investigating several alloy steels and its No. 28 gives promise of being even better than high-speed steel from the standpoint of non-distortion, ease of heat treatment, long life, cost, etc.

In regard to shop efficiency tests, so-called as a result of observing 13 different blanking tools operate through 113 set-ups over a period of 18 months, the company's tool-standardization department has found that in 46 per cent of the cases the set-ups were taken down for some other reason than that the tool became dull, and in the 54 per cent of the cases where the tool did get dull as shown by throwing a burr on the piece part that caused its rejection in the inspection department, by the careful selecting of any two- or three-week period of production any of the 13 tools could have been shown to be better than any of the others.

Obviously, the trying out of a single tool on a job of this type, or any other type for that matter, is a waste of time and money, as far as the conclusions regarding tool-steel quality are concerned.

Railway Machine Tool Exhibition at Atlantic City

While the railroad shops of this country are said to be full of obsolete equipment which sooner or later must be modernized, it is probable that the requirements of railroads for machine tools are overestimated. Mason Britton, vice-president of the McGraw-Hill Co., said before the recent convention of the American Gear Manufacturers' Association in Detroit that the machine tools in the plants of the Ford Motor Co., Buick Motor Car Co., and Cadillac Motor Car Co. more than equaled the combined shop equipment of all the Class I railroads in the United States.

Among the new machines which were shown at the Railway Exhibition in Atlantic City, mention may be made of the following:

The Niles-Bement-Pond Co. exhibited a wheel borer, one of the features of which is a self-centering automatic chuck which requires no tightening by wrenches. After lowering the wheel into the chuck the operator starts the machine, and as soon as the table begins to revolve the wheel is locked rigidly in the jaws. The greater the cut, the greater becomes the gripping action of the jaws. When the table is reversed the wheel is unclamped. For handling the wheel on and off the table a crane, conveniently located on the side of the machine is provided.

The Kearney & Trecker Corporation exhibited a new model of milling machine which features power rapid traverse in three directions and roller bearings. Another feature of this machine is the presence of two separate automatic pumps, one for operating the automatic flooded lubrication being located on the left of the column and the other, the cutter-coolant pump, on the right-hand side of the column.

The milling machine of the Oesterlein Machine Co. features a new type of overarm. This type of overarm forms a broad and rigid surface to receive the upward thrust of the cut. The overarm is equipped with a rack that meshes with the pinion in the column and a handwheel is mounted on the end of the pinion shaft to provide a means for shifting it.

The turret lathes shown by the Warner & Swasey Co. have been redesigned to provide greater driving power, sturdy feed trains, and extreme rigidity. Means have also been provided for protecting the ways from grit, chips, or cutting lubricant. A new model of turret lathe was shown by the Foster Machine Co. This is also equipped with a power rapid-traverse unit on the turret slide and provided with a split-ring-type binder for the hexagonal turret, while the bed has been lengthened to effect greater longitudinal feeding movements to the carriage and turret slide.

The situation in the machine-tool business is said to show a declining tendency. According to E. F. DuBrul (Assoc-Mem. A.S.M.E.), general manager of the National Machine Tool Builders Association, further recession over the summer months is probable, but no likelihood of serious depression. Elaborating on this subject, he says:

"It has been remarked by numerous observers that for some reasons not yet understood, the fluctuations of business seem to have a decreasing tendency, and it is a fair assumption that this is due to more intelligent guidance of business policy on the part of important business elements. Whatever may be the reason, the general business curve is tending to flatten out, and the fluctuations are tending to become less violent, although perhaps more frequent.

"How long this condition will last is a question; but however long it lasts, it has a material bearing on management policy, which must be adjusted to the conditions and not to desires for other conditions. While industry has not had any very great booms these last few years, this very fact is a protection against the great depressions that inevitably follow them. It is much better to have mild fluctuations of activity than the wild ones of the past. We see no signs of serious depression, but we can reasonably anticipate some further summer dullness in orders."

Speaking of equipment demand, Mr. DuBrul says, "The gradual recession in machine-tool orders since last October can be taken as an index of general equipment conditions, and indicates that production is not being limited by the equipment factor at this time." (Abstract based on report in *The Iron Trade Review*, vol. 78, no. 22, June 3, 1926, pp. 1441–1444 and 1477.)

Fig. 1 World's Shale-Oil Deposits

Development of the Shale-Oil Industry in California

By G. W. Wallace,[1] San Francisco, Cal.

The enormous deposits of oil shale in the United States make it probable that large quantities of oil will eventually be produced from this source. While the distillation of shale oil dates as far back as 1838, it is only recently that successful processes have been developed, which are analogous to the processes used for the carbonization of coal. The author gives particulars regarding some very interesting experimental plants that he has developed, in which conditions are most favorable for a maximum recovery of best-quality oil. A description of the process is followed by careful estimates of plant costs and data on plant yield and oil composition. The author draws the conclusion that a shale-oil industry can be profitably established at the present time, and increased to the point where it will be an important industrial factor.

The deposits of oil shale in the United States are almost inexhaustible, and it is probable that ultimately the industries of this great country will be dependent on oil produced from both coal and oil shale. For this reason the mechanical and chemical engineer will find a profitable and interesting field of endeavor in the infant oil-shale industry, the subject-matter of this paper.

Origin, Properties, and Distribution of Oil Shale

Oil shale may be defined as a rock of sedimentary origin containing organic or bituminous matter which yields oil when distilled. True oil shale contains organic matter not appreciably soluble when extracted with ordinary solvents for petroleum and yielding over 33 per cent ash. In California the material is a bitumen-impregnated diamataceous shale, usually of the Monterey formation. The oil-forming constituents can be entirely extracted with certain solvents. On evaporation of the solvent a solid resinous substance, of unknown composition, remains. The oil shales found in Utah and Colorado contain organic substances of a pyrobituminous nature, which have been termed "kerogen." Kerogen is a Greek word meaning "producer of wax." The California shale does not produce wax, and similarly there are many other shales classified as true oil shales which do not yield wax. It is thought the definition first given is sufficient.

In regard to the origin of oil shale, there is considerable disagreement. Cunningham Craig advances the theory that an "oil-shale field may be considered as the relics of a former oil field." R. D. George says: "The general similarity of the geology of oil shales to that of coals suggests that the geological conditions and processes favorable for the making of the one were also required for the making of the other—both were formed in swamps, lagoons, deltas, estuaries, and lakes......A few coal and a few oil-shale deposits were probably formed largely or wholly under marine conditions."

Fig. 1 is a map of the world whereon various oil-shale deposits of commercial importance have been indicated, the black dots showing where plants for the production of oil have been installed. Each continent has vast oil-shale resources. In the United States the oil-shale deposits of Colorado and Utah alone can furnish upward of fifteen times the amount of oil taken from the wells of this country to date, and there are vast deposits of shale in many other states, including California.

Characteristic Formation of Shale Deposits

Figs. 2 and 3 show the characteristic formation of the Colorado-Utah deposits. This shale, while of somewhat massive formation, is distinctly laminated. A specimen of the same shows fine, thin streaks of pyrobituminous substances.

Fig. 4 indicates the character of the California formation. This photograph shows the N-T-U Company's pit, from which 10,000 tons of shale have been mined by open-cut methods and distilled in the company's plant. This shale is of massive formation, a specimen showing very even distribution of the bituminous matter. The overburden has ranged between 3 and 30 ft. Shale of commercial value has been found on all sides of the hill shown in the photograph at elevations between 740 and 850 ft.

Distillation Processes

The oil-forming matter of the shale being a non-volatile complex solid substance, is broken up by heat through a rupture of the molecules, an immediate rearrangement of the elements ensuing with the formation of simpler compounds capable of existing at the higher temperature. These products are water, oil, gases, and a

[1] Consulting Engineer. Mem. A.S.M.E.

Presented at a meeting of the San Francisco Section of The American Society of Mechanical Engineers, San Francisco, Cal., November 19, 1925. Abridged.

certain amount of nitrogenous and sulphur compounds. The nature of the new products must vary as the heat is increased or diminished. "Destructive distillation" is the term applied to such processes, sometimes called "carbonization," particularly in the manufacture of gas or coke.

The shale-oil industry probably started as such in France in the year 1838, and in Scotland in the year 1850. At that time, however, considerable progress had already been made in the art of distilling coal, which dates back to the work of William Murdock in 1779, and in 1841 the D-shaped horizontal retort came into general

FIG. 2 CHARACTERISTIC FORMATION OF COLORADO-UTAH DEPOSITS

FIG. 3 CHARACTERISTIC FORMATION OF COLORADO-UTAH DEPOSITS

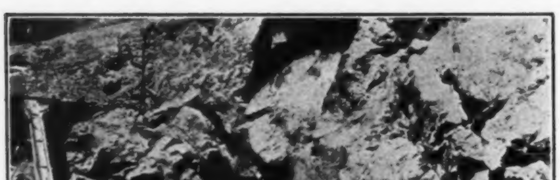


FIG. 4 CHARACTER OF CALIFORNIA FORMATION

use for the carbonization of coal. Between these dates a large number of processes were devised, and many of the proposed processes now being tried out in this country for the production of oil from shale bear a great resemblance to the methods used and discarded during the infancy of coal carbonization. Of recent years great improvements have been made in the art of coal carbonization, and in Scotland some advance has been made in the distillation of oil from shale.

Figs. 5 and 6 show the similarity of one modern coal-carbonization plant to the best-known Scottish shale process, Fig. 5 being a sectional view of the Glover-West continuous vertical retort, and Fig. 6 a section and elevation of the well-known Pumpherson shale retort. Both are externally heated.

The Pumpherson retort consists of two sections; the upper section of cast iron and the lower two-thirds of firebrick; the shale is fed continuously through the retort at the rate of approximately four tons per day, depending upon the richness of the shale. Most of the oil is formed in the upper cast-iron part of the chamber where the temperature maintained is relatively low, averaging around 1100 deg. fahr. In the brick portion the spent shale is heated to a final temperature of approximately 1800 deg. fahr., and is steamed for the production of ammonia. The amount of steam used is about 900 lb. to each ton of shale distilled.

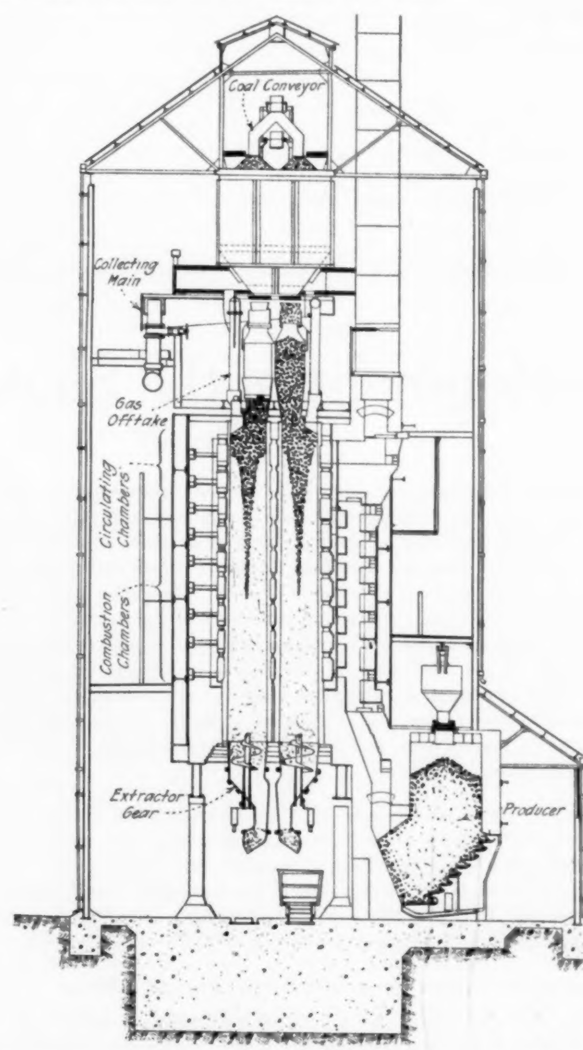


FIG. 5 GLOVER-WEST CONTINUOUS VERTICAL RETORTS, COAL-CARBONIZATION PROCESS

The cost of a Pumpherson retorting plant is approximately $2000 per barrel (42 gal.) of daily capacity, and if we consider American shale as yielding approximately 1 bbl. per ton, then the capital cost would be $2000 per ton-per-day capacity, and a 1000-ton Pumpherson plant would cost in excess of $2,000,000. The Scottish retorting plants are not effective where rich shales are distilled.

In the Scottish plants sulphate of ammonia is a major product, and for this reason the use of steam at the high temperature mentioned is necessary as it increases the yield of ammonia many times over that obtained otherwise. Many shales do not contain sufficient nitrogenous matter to warrant the additional plant and operating costs.

Some years ago when the author was superintendent of the St. Clair County Gas and Electric Company, a retort (Fig. 7) was developed embodying somewhat different principles. A battery

of six of these retorts was erected by the American Gas Company at Petersburg, Va., and a single retort was erected for the D'Arcy Exploration Company near Moncton, New Brunswick. Nearly a year was expended in experimental work, and much useful information was obtained.

At a relatively low temperature a small quantity of gas is evolved from shale, but the decomposition is slight below 750 deg. fahr., at which temperature it can be completely carbonized. The evolved products are principally water, oil, and gas. As the temperature is raised the degree of disassociation increases, the volume of gas becomes greater, and the quantity of oil becomes less.

In the ordinary processes of carbonization using an externally heated retort where the outlet for the gases and vapors is located at one end, the tendency is for the volatile products to pass through the incandescent spent shale and along the heated wall of the retort to the outlet. In this manner the oil vapors are heated above the temperature of their formation. This results in secondary and tertiary decomposition of the first-formed oil.

The action of this heat on the hydrocarbons results in the gradual separation of the hydrogen from the carbon, and by long-continued exposure to a high temperature this separation can be made nearly complete; but under ordinary conditions intermediate products are formed, only a portion of the hydrogen and carbon being separated in the free state. For this reason, where the conditions are such that the oil after its formation is subjected to prolonged or increased heating, large quantities of permanent gases will be formed at the expense of the oil. On the other hand, if the temperature at which the shale decomposes with the formation of oil and gases is the highest temperature to which these products are subjected during the carbonizing process, then the conditions are most favorable for a maximum recovery of best-quality oil.

The retort used in New Brunswick is believed to give more nearly the desired condition than any other externally heated retort, as in it the gases and vapors are led inwardly away from the heated wall of the retort, and, taking advantage of gravity, are

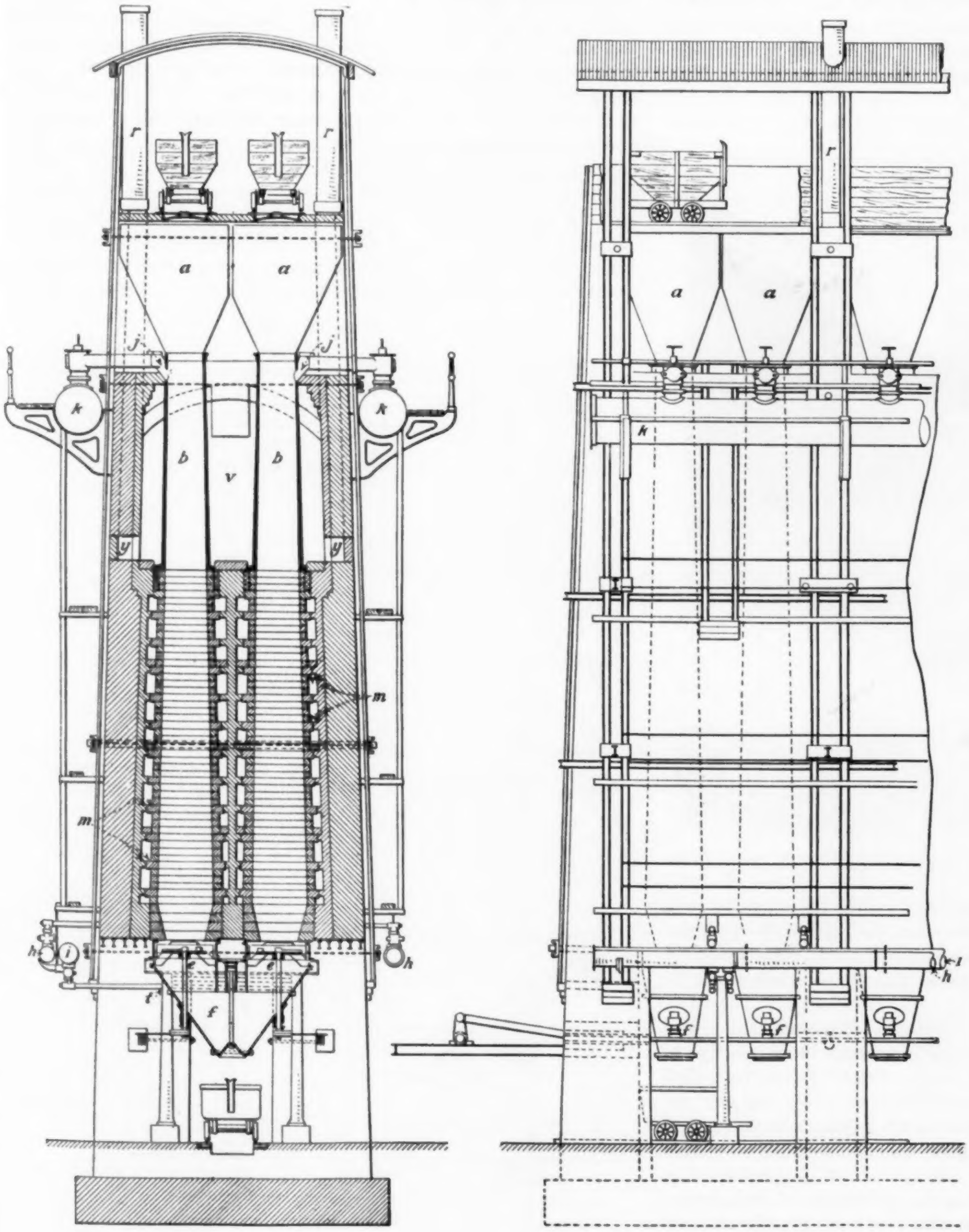


FIG. 6 PUMPHERSON SHALE RETORT

(*a*, Raw-shale charging hopper; *b*, Cast-iron retort; *d*, Firebrick retort; *e*, Spent-shale discharge mechanism; *f*, Spent-shale hopper; *h*, Fuel-gas supply main; *i*, Steam-supply main; *j*, Vapor offtake; *k*, Vapor header; *m*, Furnace-wall support bricks; *r*, Stacks; *t*, Steam inlet; *v*, Retort oven; *y*, Retort-oven flue.)

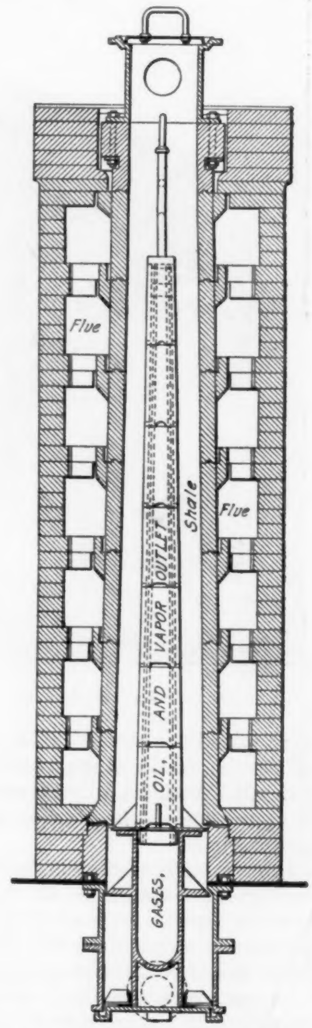


FIG. 7 SHALE RETORTS ERECTED BY THE AMERICAN GAS CO.

conducted downwardly and out of the central collection chamber. A materially increased yield of oil was obtained from both shale and coal, and the quality of this oil from a refining standpoint was improved over the yield and quality of the oil produced from the same material in an externally heated retort wherein the oil as formed was not protected from unnecessary overheating.

Shale oil is far more complex than ground oil. Its principal components include various members of the two principal series of hydrocarbons, namely, the aliphatic or open-chain compounds, and the aromatic or cyclic compounds. It always contains a high percentage of unsaturated hydrocarbons, often as high as 90 per cent. It is thought that these hydrocarbon groupings are somewhat joined together. This is illustrated by the fact that a crude oil showing 90 per cent unsaturation when distilled under pressure will yield products only 20 per cent unsaturated, and composed of approximately 40 per cent aromatic and 40 per cent aliphatic hydrocarbons.

FIG. 8 40-TON N-T-U COMPANY'S SHALE-OIL PLANT

From a study of the data obtained in New Brunswick, it would seem evident that shale oil should be produced in as nearly its formative state as possible, and then refined under controlled conditions, rather than that a combination of retorting and refining should be attempted. Where this combination is attempted it means overheating and cracking of the first-formed oil under conditions not favorable to the production of highest-quality products—usually with an increase in the percentage of undesirable unsaturated hydrocarbons, which in turn results in greater refinery losses.

THE N-T-U COMPANY'S CALIFORNIA WORK

During the year 1922 the N-T-U Company erected in Santa Barbara County a 20-ton experimental, semi-commercial plant using the process of the S E Company organized for the purpose of engaging in shale-engineering work. A year's operation demonstrated the practical value of the process, and was followed by the construction of a 40-ton unit (Fig. 8). This unit was operated for a period of nearly two years under experimental conditions, and data were obtained covering every possible method of operation. In the design of three additional 40-ton units no major changes were made, but arrangements were provided for furnishing increased amounts of gas and air, varied to meet the requirements of any particular type of shale. The mechanism controlling the discharge of spent shale was installed so as to shorten the time required for this operation. The first generator was changed to conform with the three new ones, and the scrubbing and condensing equipments were built large enough to form the first units of future extensions. Fig. 9 is a side elevation of the plant. Each unit consists of a steel shell 11 ft. in diameter and 24 ft. high, lined with firebrick, and is called a generator in contradistinction to externally heated retorts. The charge is 40 tons of crushed shale, and requires about 24 hours for complete distillation.

The process functions as follows: The shale is transported from the mine, or pit, over standard-gage track in a steel car of 40 tons capacity to a position directly over the charging door at the top of the generator, and charged into the generator from the hoppers at the bottom of the car. The generator charging door is then closed and gaseous combustion initiated above the charge, the gases being those produced during the distillation of the shale. The quantity of gas and air is regulated by the valves as shown by the drawing, and the mixture usually consists of approximately 60 parts gas and 40 parts air, depending on the type of shale being distilled and the B.t.u. value of the gas. The quick-opening valve connected with the bottom outlet of the generator is opened the proper distance and the draft gases caused to pass downwardly through the charge. The common gas and vapor pipe is under partial vacuum and connected with standard scrubbing and condensing units as well as a fan-type gas exhauster.

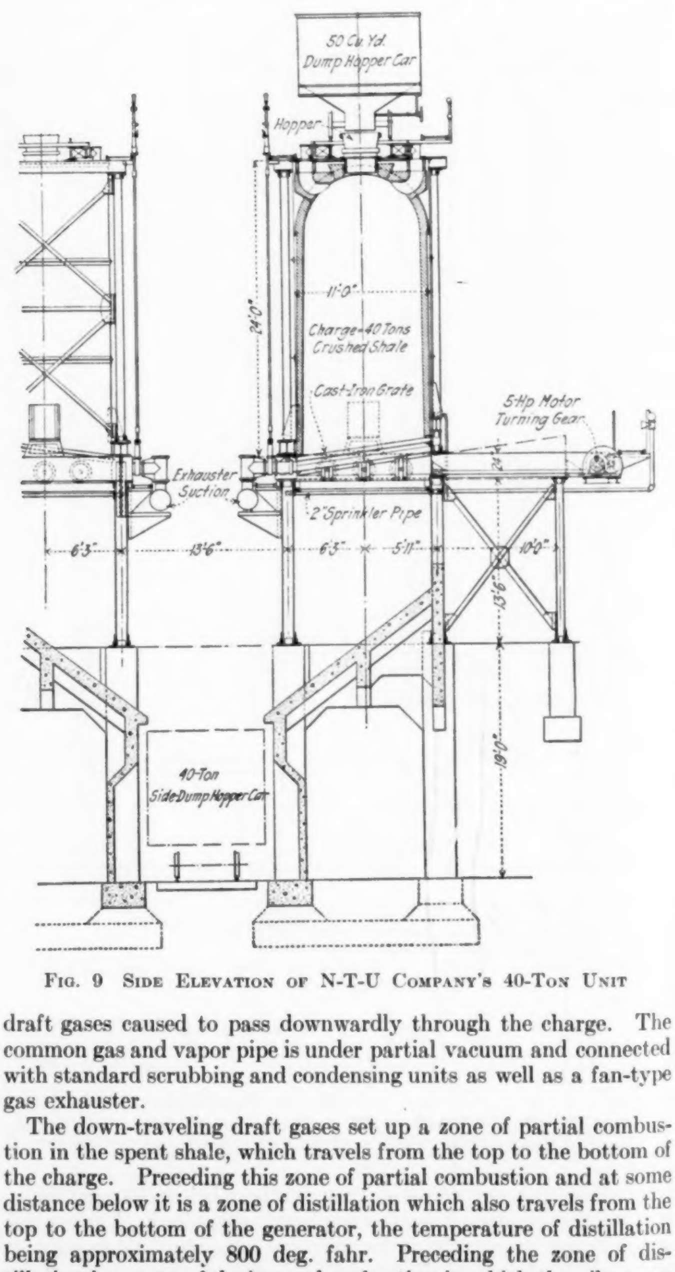


FIG. 9 SIDE ELEVATION OF N-T-U COMPANY'S 40-TON UNIT

The down-traveling draft gases set up a zone of partial combustion in the spent shale, which travels from the top to the bottom of the charge. Preceding this zone of partial combustion and at some distance below it is a zone of distillation which also travels from the top to the bottom of the generator, the temperature of distillation being approximately 800 deg. fahr. Preceding the zone of distillation is a zone of drying and preheating in which the oil vapors are cooled almost immediately after their formation.

The temperature of the draft gases approaches 2000 deg. fahr. The gaseous combustion is controlled so as to be nearly complete in the top of the chamber, and an excess of oxygen is avoided.

Little, if any, of the oil in the upper part of the charge is burned. On starting, the apparatus is relatively cool, and the heat is absorbed rapidly. For this reason the distillation of the shale usually has advanced the charge down a sufficient distance to be out of the way of harm before the temperature becomes excessive. As no free oxygen is present in the zone of distillation, oxidation of the oil is impossible.

As soon as the temperature of the spent shale reaches incandescence, the usual producer-gas reactions commence taking place; that is, the CO_2 and H_2O resulting from the gaseous combustion are reduced by the incandescent carbon to CO and H_2. This producer-gas zone becomes larger as the operation progresses, and when it reaches, say, two to three feet, the reactions are nearly complete. As a result of this producer-gas reaction, which is highly endothermic, the gases leaving this zone are greatly reduced in temperature, and it is possible through control of the air and gas mixture to cause the temperature of the gases leaving the producer-gas zone to remain relatively constant at the desired temperature. The limits of this regulation range between 1400 and 1800 deg. fahr., and as a result of it the zone of distillation can be maintained a sufficient distance below the high-temperature zone to prevent harmful overheating of the primarily formed oils.

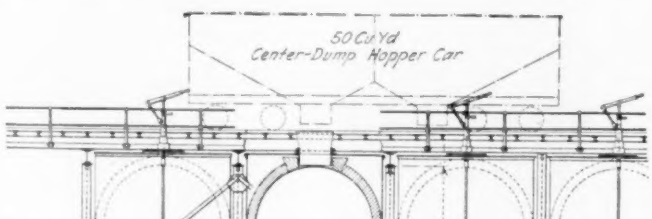


FIG. 10 FRONT ELEVATION, PART IN SECTION, OF FOUR RECENTLY COMPLETED UNITS

Where desired, the producer-gas zone can be made a zone of combustion by admitting air diluted with relatively inert gases to modify its oxygen content, in which case some of the carbon in the spent shale will be burned to CO_2.

If steam without gases is used as the endothermic, it is found to be too violent, and the zones of combustion and distillation are not separated by a great enough distance to prevent harming the oil. This may be explained as follows: Using air without modification, the temperature of the zone of combustion, or fire, is directly proportional to the velocity or quantity of air passing through the fire,

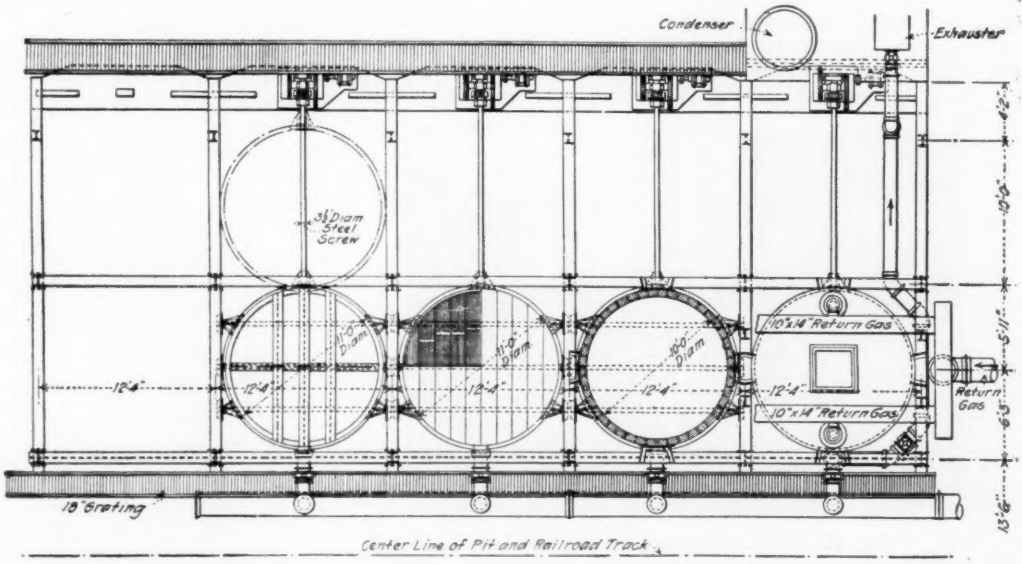


FIG. 11 FOUR UNITS IN PLAN, WITH DETAILS OF BRICK LINING AND GRATES

and the temperature of the gaseous medium of distillation is proportional to both the temperature of the fire and the air passing through it. When the air is modified by returning with it some of the gases produced during the distillation, the temperature of the fire or zone of combustion is inversely proportional to the amount of modification. Thus the temperature of the gaseous medium of distillation is lower while the quantity of draft gases is greatly increased, thereby permitting the transfer of a greater quantity of heat under lower temperature conditions than is possible when using air alone, or air and steam. The result of this is to push the zone of distillation a much greater distance in advance of the zone of combustion, thereby protecting the oil as formed and allowing an increase in the rate of distillation.

The company's experience in operating the 40-ton unit has shown that both the zones of combustion and distillation can be controlled. One illustration should be sufficient. During the first year and a half virtually every charge of spent shale was clinkered and fused excepting a small cone of partially distilled shale resting on the center of the grate. This clinker formed a shell around the shale and prevented free passage of the draft gases. During this period approximately 70 per cent of air and 30 per cent of gas was being used. A zone of combustion existed in and passed through the spent shale. During the last half of the second year, after certain patent protection had been obtained, the ratio of gas and air was changed to 60 parts gas and 40 parts air. This gave virtually complete combustion of the gas above the column of shale with no excess oxygen, and with this mixture no clinker was formed, the shale was not fused, and the draft gases had free passage from the top to the bottom of the generator. The distillation was virtually complete. The yield of oil was increased and its quality improved. Considerably less trouble was encountered through the formation of emulsions difficult to break up.

The method of supporting the brick lining is quite important. Provision has been made for renewing the portions of this lining subjected to greatest wear without disturbing the rest of the lining.

The combustion gases along with the proper amount of air are brought into the top of the generator at two places and are thoroughly mixed so as to give a uniform combustion above the charge. The operation of starting the generator is all controlled from the

upper level. At the end of the operation, that is, when the distillation is complete, the gas valves are closed, the top charging door opened, and the bottom closure is withdrawn latterly from under the charge. This bottom closure consists of a 4-in. cast-iron grate, supported above an oil and vapor receptacle which is connected with the offtake as shown. The grate is inclined so as to reduce friction during its withdrawal. It is operated by a motor-driven worm gear and threaded shaft. In the new units it will take approximately five minutes to discharge each generator. As the shale drops from the generator it is deflected by an inclined reinforced-concrete slab into the spent-shale car. This car conveys the spent shale to the dump and is moved by a gasoline locomotive.

Four pyrometers are located in the center of each quarter of the vapor chamber just under the grate. These pyrometers indicate the completion of distillation and also tell whether the charge is distilling evenly. The zone of distillation is usually not level. The inclination, however, does not affect the operation.

FIG. 12 FOUR-UNIT PLANT FROM AN ANGLE

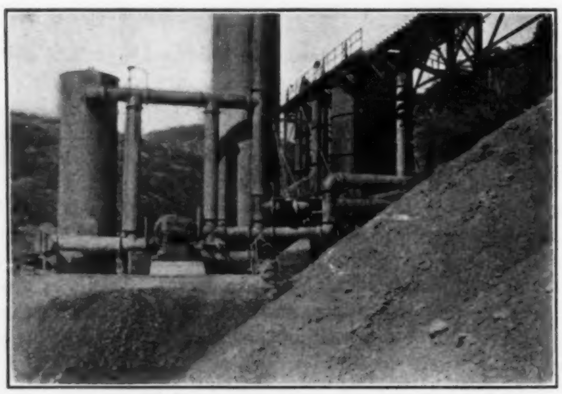


FIG. 13 SCRUBBER, CONDENSER, AND GAS EXHAUSTER

Fig. 10 is a front elevation, part in section, of the four units which have just been completed. Fig. 11 shows the four units in plan and gives a little further information regarding the construction of brick lining and grates. It will be noted that the wheels carrying the bottom doors operate on each side of the 24-in. I-beam which acts as a track and also supports the generators.

Fig. 12 shows the four-unit plant from an angle and gives a little better idea of the foundation construction as well as of the inclined concrete slab which deflects the residue into the spent-shale car; the car operates directly in front of and below the inclined slabs.

Fig. 13 shows the scrubber, condenser, and gas exhauster, and details of these are shown in Figs. 14 and 15. This equipment represents standard gas-plant practice throughout the country. The gas exhauster is a No. 8 motor-driven, fan-type, Sturtevant machine. The gas passes from the generators to the scrubber, where most of the oil is condensed. Condensation of water in the scrubber is avoided as far as possible in order to prevent troublesome emulsions. From the scrubber the gas passes to the exhauster and then to the condenser, where such oil and water as has not already dropped from the gas is condensed. From the condenser the gas passes to a water seal, where the required amount is returned to the generators under regulated pressure, the surplus gas going to boiler plant.

There will be more than enough surplus gas to furnish all the power required, and sufficient steam will be generated to warm the oil where needed and operate pumps where variable flow is required.

COST ESTIMATES

The mining costs in California will not be comparable with similar costs elsewhere. The mining and crushing costs will probably not exceed 35 cents per ton during the period in which the four units, shortly to go into operation, are worked. With a 1000-ton operation the mining cost may drop below 20 cents.

Table 1 is an estimate of expected costs operating the four units, and it is believed this estimate will be met. On test runs of the 40-ton plant under the supervision of disinterested engineers, plant costs were obtained ranging between \$1.10 and \$1.37 per ton, exclusive of supervision and fixed charges. Table 2 shows the estimated cost of operating a 1000-ton plant. The capital cost of this plant will be in the neighborhood of \$450,000, and including mining equipment for California operation, \$500,000.

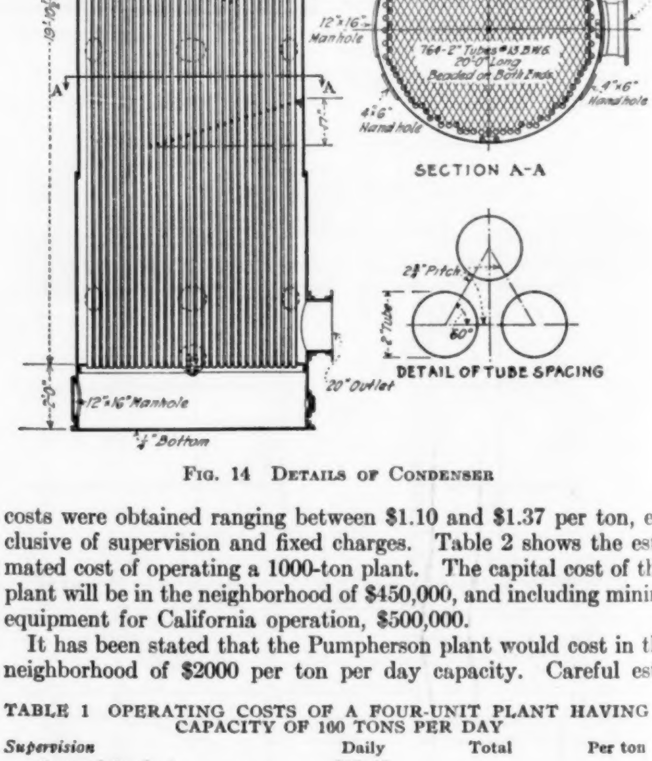


FIG. 14 DETAILS OF CONDENSER

It has been stated that the Pumpherson plant would cost in the neighborhood of \$2000 per ton per day capacity. Careful esti-

TABLE 1 OPERATING COSTS OF A FOUR-UNIT PLANT HAVING A CAPACITY OF 100 TONS PER DAY

	Daily	Total	Per ton
Supervision			
1 superintendent	\$10.00		
1 chemist-clerk	6.00		
1 foreman	7.00		
Total	\$23.00	\$23.00	\$0.14
Plant Operation			
3 operators	\$16.50		
1 spent-shale man	5.00		
1 yard man	4.50		
1 mechanic	6.00		
Total	\$32.00	32.00	0.20
Supplies and Expense			
Electric power	\$25.00		
Water and supplies	24.00		
Total	\$49.00	49.00	0.31
Total Plant Operation		104.00	0.65
Mining costs		56.00	0.35
Total cost per ton		\$160.00	\$1.00

mates have been prepared covering the cost of installing a modern externally heated retort plant where the yield of oil alone is considered, and ammonia neglected. The lowest estimate is considerably over $1000 per ton per day capacity.

A 1000-ton plant of the S E Company process, including condensers, scrubbers, gas exhausters, steam plant, and tankage, will cost $450,000. This is exclusive of mining machinery and railroad trackage. This figure is thought to be high. Table 3 gives the materials that are required for a 1000-ton plant with the above exception, and not including boiler plant or tankage.

Plant Yields

Various types of shale have been successfully distilled in the 40-ton unit, including shale from England and Utah. Between six and seven thousand tons of California shale have been distilled, in addition to more than 3000 tons distilled in the 20-ton plant. There has never been a failure in operating the 40-ton unit. There have been runs where the yield of oil was off due to poor conditions, but every charge has been distilled and the spent shale discharged

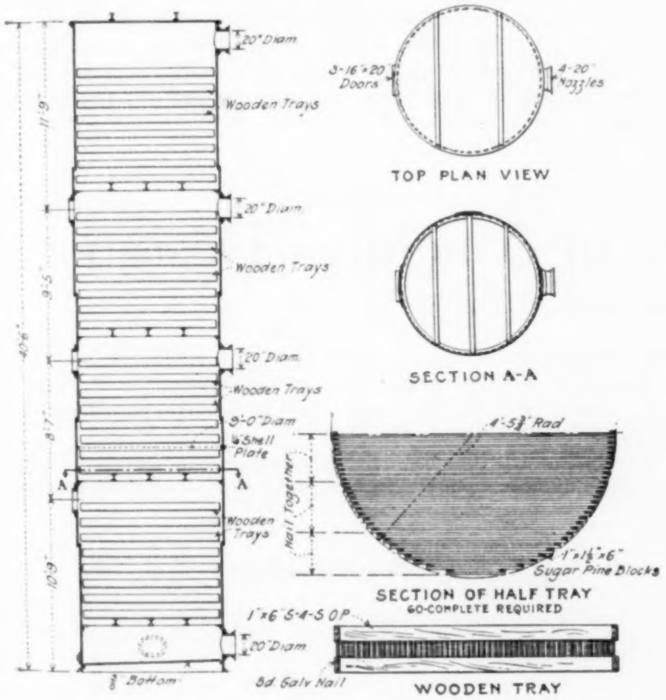


FIG. 15 DETAILS OF SCRUBBER

without trouble. Experience shows that a yield of at least 90 per cent may be counted upon.

Table 4 shows the results obtained on California and Utah shales, the plant at the time of these tests being under the supervision of qualified disinterested engineers.

The statement can be definitely made that shale oil is refinable, and, so far as is known, virtually every product now produced from ground oil can be furnished from shale oil. The composition, and in some cases the properties, will be different, but so far as the use of the products is concerned, industrial requirements can and will be met; in other words, lubricating oils, greases, motor fuel, kerosene, fuel oil, paraffin, wax, etc. of good quality can be produced. It is believed that the motor fuel will be superior to that now on the market. At any rate, it will answer the new Navy specifications.

Shale oil can be cracked by any of the well-known cracking processes and a high yield of good-grade motor fuel produced. That from the California shale oil will contain some sulphur, but not an objectionable amount. In every other respect it conforms to the new Navy specifications.

Table 5 contains data on California and Utah shale oil. The cracking results were obtained by Dr. Roy Cross, of the Cross process. The other figures were obtained in the company's laboratory.

TABLE 2 ESTIMATED COST OF OPERATING A 1000-TON-PER-DAY PLANT

	Daily	Total	Per ton
Supervision			
1 superintendent	$10.00		
1 chemist	8.00		
1 assistant chemist	6.00		
1 clerk	5.00		
2 foremen	13.00		
Total	$42.00	$42.00	$0.042
Plant Operation			
3 operators at $5.00	$15.00		
3 helpers at 4.00	12.00		
6 spent-shale men at 4.00	24.00		
4 charging men at 4.00	16.00		
4 yardmen at 4.00	16.00		
Total	$83.00	83.00	0.083
Maintenance			
1 master mechanic	$ 8.00		
2 mechanics	12.00		
1 electrician	7.00		
2 helpers	10.00		
Total	$37.00	37.00	0.037
Supplies and Expense			
Electric power	$100.00		
Supplies	150.00		
Total	$250.00	250.00	0.250
Mining			
40 men	$200.00		
Powder and supplies	50.00		
Total	$250.00	250.00	0.250
Total Cost per Ton		$662.00	$0.662
Fixed Charges			
Interest, taxes, insurance, depreciation		220.00	0.220
Total		$882.00	$0.882

TABLE 3 MATERIALS REQUIRED FOR A 1000-TON PRODUCTION PLANT, EXCLUSIVE OF CARS, TRACKAGE, AND MINING EQUIPMENT

Structural steel and plate, 1000 tons	$220,000
Firebrick linings, 750 tons	50,000
Reinforced concrete, 1650 cu. yd.	50,000
Gas exhauster, pumps, motors, etc.	30,000
Tankage	10,000
Small piping and electric wiring	5,000
	$365,000
40-ton steel cars, approximately	20,000
Total	$385,000

TABLE 4 PLANT YIELDS

	California shale	Utah shale
Shale per charge, tons	38	40.75
Time required for distillation, hr.	24	22.7
Net oil recovered, gal.	1361	1906
Oil per ton shale, gal.	35.8	46.8
Oil lost in gases, gal.	4.2[1]	4.0
Total oil accounted for, gal.	40.0[1]	50.8
Assay value of shale, gal.	41.6	52.5
Per cent recovery	86.0	89.1
Per cent accounted for	96.0	96.0

[1] This result is an average; oil in gases not determined on this charge. As plant has been operated experimentally under variable conditions, average results are not given. A net oil recovery of about 90 per cent is expected.

TABLE 5 ANALYSIS OF OILS

	California		Utah	
Specific gravity of crude	0.986		0.931	
Baumé gravity API	12.0		20.5	
Per cent sulphur in crude	6.77		0.47	
Per cent nitrogen in crude	0.54		...	
	Temp., deg. fahr.	Sp. Gr.	Temp., deg. fahr.	Sp. Gr.
Fractional distillation:				
I.B.P.	400		370	
10%	506	0.898	460	0.830
20%	546	0.915	538	0.863
30%		0.941		0.887
40%		0.964		0.907
50%		0.981		0.930
60%		0.987		0.940
70%		1.007		0.955
80%		1.002		0.963
Distillate, per cent		90		97
Coke and loss, per cent		10		3
Carbon, per cent		1.2		7
Cracking Results, Ultimate, Based on Raw Oil without Coking:				
Per cent gasoline		55.0		58.0
Per cent fuel oil		34.0		31.0
Per cent loss gas and carbon		11.1		11.0
ANALYSIS OF SHALES				
Moisture, per cent		3.18		1.28
Volatile matter, per cent		24.28		32.51
Fixed carbon, per cent		12.12		14.51
Ash, per cent		60.42		51.70
Sulphur, per cent		2.17		1.01
Nitrogen, per cent		0.38		0.85

ANALYSIS OF ASH

Silica (SiO_2), per cent	72.76	46.17
Iron Oxide (Fe_2O_3), per cent	4.95	5.70
Aluminum (Al_2O_3), per cent	12.95	9.93
Lime (CaO), per cent	3.66	18.60
Magnesia (MgO), per cent	1.60	10.67
Alkalis and undetermined	4.08	8.93

BY-PRODUCTS

While the N-T-U company has not overlooked by-products, it has realized that these values are hypothetical. A considerable portion of the oil produced to date has been sold as flotation oil, and the reported results obtained from various mining companies have been favorable. Where the nitrogenous content of the shale is high enough to warrant the production of sulphate of ammonia, the process can be so functioned as to give a relatively high yield of this commodity, due to the fact that the spent shale reaches a high temperature in the presence of water vapor. It should be stated that less than 40 per cent of the nitrogen is given off during carbonization, the remaining 60 per cent being retained in the spent shale. To recover some of this 60 per cent as ammonia requires subjecting the spent shale at high temperature to the action of steam. In either phase not all of the nitrogen is recoverable as ammonia.

CONCLUSION

Many of the larger oil companies have investigated shale oil and have acquired large holdings of shale lands in Colorado and Utah. The United States Navy has set aside a shale reserve embracing many thousand acres.

In the United States domestic consumption of crude oil has exceeded production since the year 1911, with the exception of the year 1923, the consumption exceeding the production by an amount ranging from 40 to 90 million barrels between the years 1917 and 1922, and during 1924.

While many of the engineers in charge of the development work of the larger oil companies have concluded that the refining of shale oil would require large capital expenditures in the modification of existing refineries, the author believes that no important changes will be required in the equipment used for refining ground oil when shale oil in sufficient quantities is furnished to enable capacity operation. The temperature and specific gravity at which the various fractions are cut during distillation would be different, and in refining the chemical treatment of the products would be modified.

In conclusion, it may be said that the N-T-U Company through its development work has shown that a shale-oil industry can be profitably established at the present time, and that the magnitude of this industry can be increased to the point where it will be an important industrial factor. Further, that it is not necessary to delay this development until the time arrives when it is definitely certain that ground oil is finally and unquestionably on the decline.

Non-Technical Features of Machine Design

BY MAX M. FROCHT,[1] PITTSBURGH, PA.

GENERALLY speaking there are two aspects to the engineering of most any project: a technical, requiring a knowledge of the fundamental sciences, such as physics, mathematics, and mechanics; and a non-technical, calling for experience and sound judgment. The four years the average engineering student spends in college are, as they should be, devoted primarily to training in fundamentals. A natural consequence of this method of training, however, is the tendency among newly graduated engineers to see all problems as slide-rule problems, to overestimate the technical part, and to underestimate the role of common sense in the engineering of a structure or machine. The purpose of this article is to bring into relief some very elementary commonsense features generally entering into the problem of machine design, and thereby, it is hoped, shorten, if even but a little, the period of transition from theory to practice; a period which, according to a Persian proverb, requires ten days of experience to one day of learning.

Given the task of developing a complete mechanism, or a portion of it, the first thought should always be to benefit from past experience. To this end all available sketches and drawings should be looked up and studied. They may frequently serve as a starting point, and often suggest a way to marked improvement.

In developing a mechanism the keynote should be simplicity. No design can be considered satisfactory which merely does the work. This is of course the first requisite of any mechanism, but for a design to be truly satisfactory it must accomplish its task with the minimum number of simple parts, by a simple part meaning a part that can be manufactured or purchased at least cost.

Some years ago a certain machine company of Detroit, Michigan, was building a sterilizer for condensed milk. The mechanism was rather simple. It consisted chiefly of a closed cylinder filled with steam, in which cases of condensed milk were carried by a slowly revolving shaft and thus brought under the influence of the heat. The specific problem was to design a sterilizer of much larger dimensions than those built before. On consulting the old drawings the sterilizer entrance was found to be substantially as shown in Fig. 1. No satisfactory reason could be found for the separation of the two castings *A* and *B*. They were therefore combined into one integral part, which procedure effected a considerable saving in the cost of production, as well as an improvement in the mechanism, since an annoying source of steam leakage was definitely removed.

To illustrate further, the author recalls a demonstration of an ingenious universal joint which probably was all one could desire

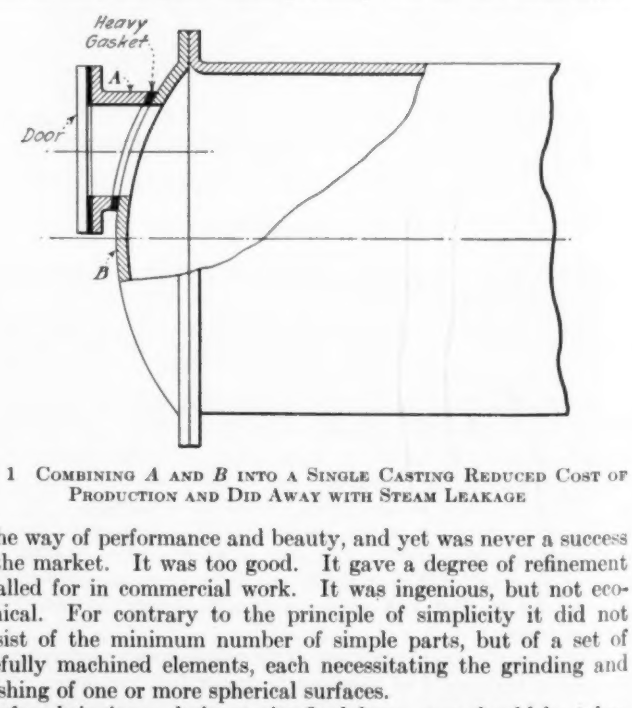


FIG. 1 COMBINING *A* AND *B* INTO A SINGLE CASTING REDUCED COST OF PRODUCTION AND DID AWAY WITH STEAM LEAKAGE

in the way of performance and beauty, and yet was never a success on the market. It was too good. It gave a degree of refinement uncalled for in commercial work. It was ingenious, but not economical. For contrary to the principle of simplicity it did not consist of the minimum number of simple parts, but of a set of carefully machined elements, each necessitating the grinding and polishing of one or more spherical surfaces.

Before bringing a design to its final form, care should be taken to ascertain that the parts can be assembled and taken apart with a fair degree of ease. The author has seen several good layouts for differential housings with the one shortcoming that the thrust and radial bearings could be put together by a magic hand only, since the smallest outside diameter of these bearings was one-fourth of an inch larger than the largest opening in the housing.

[1] Department of Mechanics, Carnegie Institute of Technology.

In Fig. 2 is submitted a sketch of a water tank which is a classical example of an impossible design.

It is also important to provide for the easy replacement or adjustment of defective or worn parts. The failure to make such provisions will inevitably result in unduly high repair bills. A recent experience bears on this point. The sum of twenty dollars was asked for the labor required to put on a four-cent felt washer between the rear main bearing and the flywheel on a rather widely used automobile, the reason given being that the whole engine had to be removed to put the washer on.

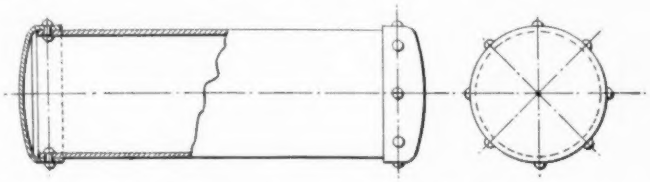


FIG. 2 EXAMPLE OF AN IMPOSSIBLE DESIGN

The same automobile has the cylinder and piston design shown at (*a*) in Fig. 3, resulting in the non-uniform wear shown in the same figure at (*b*). This design makes it literally impossible to insert the smallest oversize piston without reboring the cylinder. There are some intrinsic difficulties in producing uniform wear

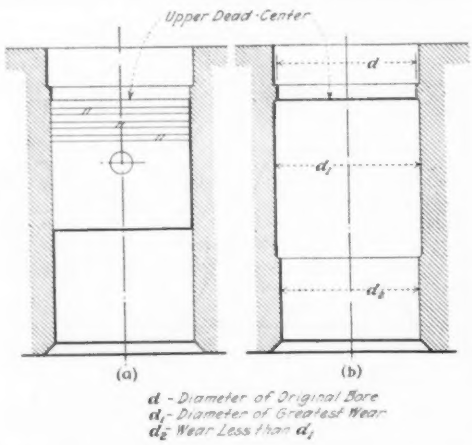


FIG. 3 CYLINDER DESIGN IN WHICH AN OVERSIZE PISTON CANNOT BE INSERTED WITHOUT REBORING

throughout the whole length of the cylinder, but nothing save lack of foresight on the part of the designer will explain the unworn neck above the top dead center and its consequent blocking of the way for an oversize piston.

The mechanism should also be examined from the point of view of clearance. Special attention should be paid to those

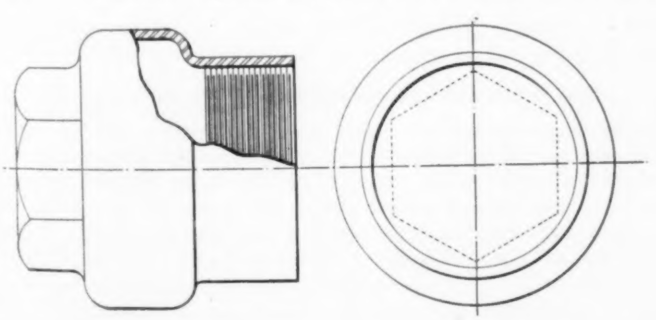


FIG. 4 IMPOSSIBLE AND ABSURD DESIGN OF HUB CAP

parts which for lack of a better term we shall call "semi-moving," that is, parts which may be stationary or moving, such as brake rods and brake levers. It is not always a simple matter to assure the absence of interference. In some cases it will tax all the visualizing power developed by descriptive geometry, and more.

As the details of a mechanism approach completion it is important to think of the way in which they will be made. Just as a mechanism is satisfactory only when reduced to the minimum number of simple parts, so is a part satisfactory only when it can be manufactured with a minimum number of simple operations. The failure to examine a design from this point of view may necessitate employing complicated jigs and fixtures, and may raise the cost of production of a part to a point where its use becomes prohibitive. And in some cases it may even result in an impossible and absurd design, as, for example, the stamped hub cap shown in Fig. 4.

A graduate mechanical engineer working in the capacity of a checker for a large automobile concern returned to a draftsman a detail drawing a part of which is shown in Fig. 5, asking that the note calling for the drill operation be removed, since the plate was merely to fit over a rivet head, and, therefore, only the countersunk space was necessary. When the detailer pointed out that the presence of the unnecessary hole would greatly facilitate the necessary countersinking, the checker reluctantly admitted that he had never thought of that.

It is an old maxim that results obtained from theoretical computations must be submitted to the test of common sense, and if

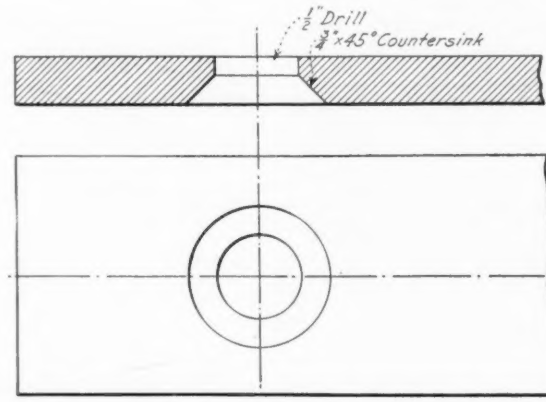


FIG. 5 UNNECESSARY HOLE IN PLATE GREATLY FACILITATES COUNTERSINKING NEEDED TO CLEAR RIVET HEAD

the two do not agree the common-sense conclusions should always be given preference, all formulas to the contrary notwithstanding. The author recalls in this connection the case where an engineer found that he would have to use a $^7/_8$-in. key for a 1-in. shaft.

Finally, all detail drawings should contain complete and clear information in the form of views, sections, dimensions, finishing marks, and notes. The need for such completeness and clearness cannot be overemphasized, as the following rather embarrassing

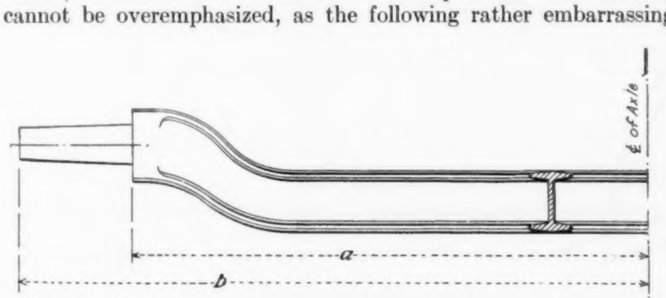


FIG. 6 A FORGING TRAGEDY

experience will show. A forged steel I-beam was designed for an experimental axle. Dies were out of the question, since the cost would have run up to something like two thousand dollars. A hand forging was ordered from a reputable forge shop and the drawing submitted was as shown in Fig. 6. Imagine the chagrin when the finished forging was found to consist of only half a beam, and that, as the forger explained, because the drawing showed only half the beam.

In conclusion, the author would say that one cannot be too careful about checking. Hasty checking, or checking one's own work, is too costly to indulge in. An hour's thought at the drafting board may save ten in the shop.

Test of World's Largest Cottonseed-Oil Mill

By C. E. ROSE,[1] LITTLE ROCK, ARK.

THE cottonseed-oil mill of the Dixie Cotton Oil Company, of Memphis, Tenn., is a 24-press mill. The rated capacity of cottonseed-oil mills is uniformly based on the number of tons of cottonseed a mill is capable of crushing per day of 24 hours, and this mill is built to extract the oil from 400 tons of seed per day. The normal operating period is 24 hours, six days per week, as state laws generally prohibit operation on Sundays; and most cottonseed-oil mills begin work at midnight Sunday and continue until midnight Saturday each week, the intervening period affording time for the necessary repairs and adjustments of equipment.

For the benefit of those unacquainted with cottonseed-oil-mill operation the author will first discuss the flow of the cottonseed and its by-products through this 400-ton mill.

The seed is unloaded from the railroad cars into conveyors parallel with the longitudinal axis of the seed house; these conveyors then transfer the seed to the center of the building, where it is delivered to another set of conveyors serving the full length of the building which distribute it to any desired bin for storage.

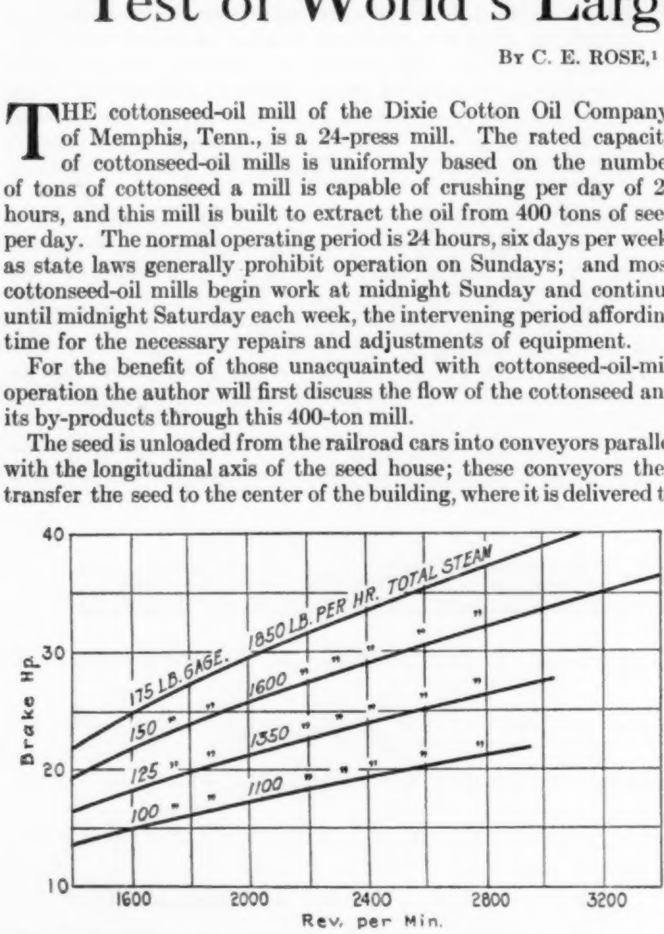


FIG. 1 TERRY STEAM TURBINE—CURVES OF TOTAL STEAM PER HOUR (HAND VALVE OPEN)

(33 hp. at 3250 r.p.m., 100 deg. fahr. superheat, and 175 lb. pet sq. in. gage.)

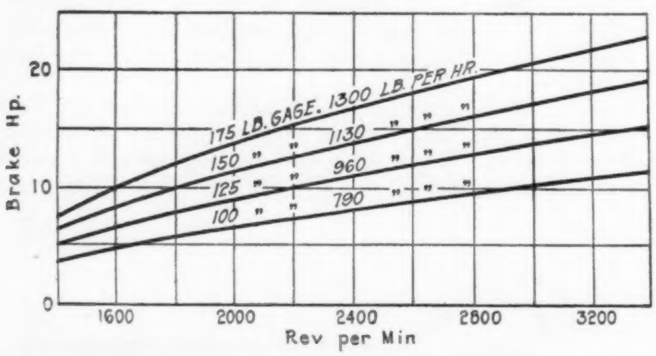


FIG. 2 TERRY STEAM TURBINE—CURVES OF TOTAL STEAM PER HOUR (HAND VALVE CLOSED)

(33 hp. at 3250 r.p.m., 100 deg. fahr. superheat, and 175 lb. per sq. in. gage.)

Cottonseed so stored heats spontaneously, and unless blown with air, which breaks contact of the kernels, loosens them up, and cools them, spontaneous combustion is certain to result; therefore stored seed must be watched and blown whenever necessary.

From these storage bins the seed is drawn at will into the center conveyor tunnel and carried to an elevator at the center of the building, which raises it to another conveyor running across the mill yard to the top of the cleaner room; thence the seed is run through the cleaners to a floor conveyor and up an elevator to the linter room, in which are located a magnetic cleaner and seventy-two linter gins, twenty-four of which are used to cut what is called "first-cut lint," after which the seed is returned by conveyor to the remaining forty-eight second-cut linter gins. From the linter room the seed is then conveyed to the huller room by elevator and conveyor, and is delivered to hulling and separating machinery; thence it is delivered to the crusher rolls, and from this point to cookers where the meats are cooked.

The meats are then taken out through meat formers where they are pressed into $13^1/_2$-lb. cakes ready for the 24 cotton-oil presses, each of which presses 15 cakes, which are operated at a pressure of 4500 lb. per sq. in. gage by a motor-driven pump using cottonseed oil as the pressure medium. The 300 lb. of oil so obtained per ton of seed runs by gravity to tanks below the press level, and these tanks are gaged at 7 a.m. and 7 p.m., the ends of the night and day shifts, respectively. The residual 849 lb. of cake per ton of seed from the presses is passed through a cake breaker and thence to cake-storage bins; from these the crushed cake is conveyed to the cake mills where it is ground into cottonseed meal, elevated to a conveyor and then carried to the meal house, where it is sacked in 100-lb. sacks, weighed, and stored or loaded directly into cars. The other by-products per ton of seed are from 35 to 40 lb. of first and 80 to 85 lb. of second linters and 630 lb. of hulls, which latter are elevated and conveyed to the hull packers, packed into 100-lb. sacks, and stored in the hull house or loaded directly into the cars.

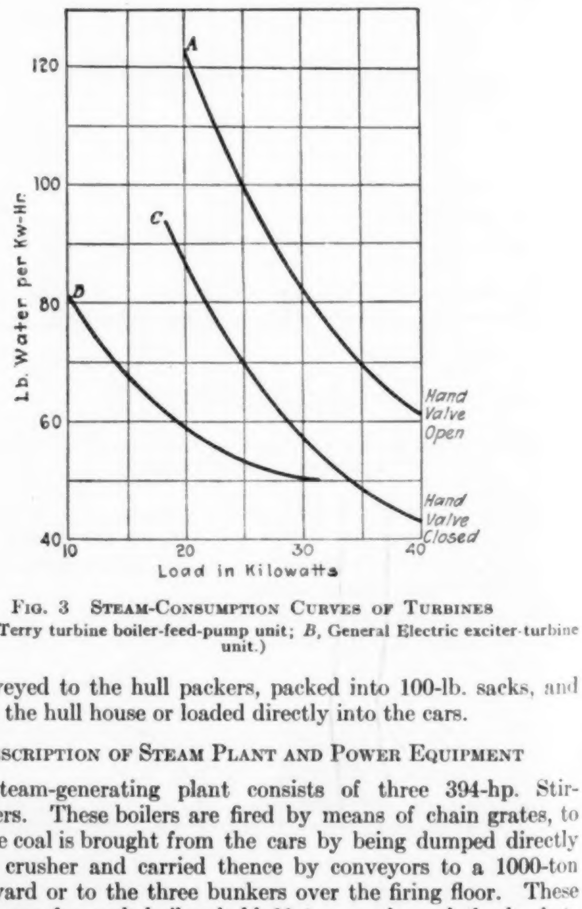


FIG. 3 STEAM-CONSUMPTION CURVES OF TURBINES

(A and C, Terry turbine boiler-feed-pump unit; B, General Electric exciter-turbine unit.)

DESCRIPTION OF STEAM PLANT AND POWER EQUIPMENT

The steam-generating plant consists of three 394-hp. Stirling boilers. These boilers are fired by means of chain grates, to which the coal is brought from the cars by being dumped directly into the crusher and carried thence by conveyors to a 1000-ton storage yard or to the three bunkers over the firing floor. These bunkers, one for each boiler, hold 60 tons each, and the buckets each deliver 350 lb. of coal at each trip to the chain-grate hoppers. Steam is generated at a pressure of 175 lb. per sq. in. gage and with 83.5 deg. fahr. superheat, and is supplied to the two 1250-kva. main turbines, the exciter turbines, the stoker engines, the boiler-feed pumps, the oil loading pump, the ejector, the meat cooker, and the meat formers. The rotative dry vacuum pumps, the cottonseed-press pumps and all other equipment are electrically driven by three-phase, 60-cycle, 440-volt motors.

The main turbine exhaust is condensed by two jet condensers; cooling water is provided by one deep well, and a spray pond of admirable dimensions eliminates the heat from the condensate.

[1] Vice-President, Arkansas Cold Storage Co. Mem. A.S.M.E.

The exhaust from the exciter and boiler-feed turbines, the stoker engine, and oil loading pump is piped to a heater, to which is also pumped the condensate from the cooker and former, and the make-up water is obtained from the deep wells. The exhaust from the throttled-down ejector is lost, but is of small amount.

All feedwater is stored above the boiler level to give sufficient head, and the discharge therefrom is through a V-notch with registering train whose sides are 12.75 in. long and width at top is 7 in. Several calibrations demonstrated that this hot-water-registering gear was absolutely undependable, and the V-notch reading was taken instead.

The power-station building is of brick, steel, and reinforced concrete, and natural draft is supplied by a brick stack 150 ft. high and 11 ft. in diameter at the top.

The power-station operating force consists of a chief engineer, a night- and a day-watch engineer, and a night and a day fireman, which is the minimum with 12-hour shifts.

A 12-hour test was run with observations made every 15 minutes in accordance with the A.S.M.E. test code and the following tabulation gives these observed values and calculated results

DATA AND RESULTS OF TEST OF THE DIXIE COTTON OIL COMPANY'S OIL MILL IN MEMPHIS, TENN.

General Information

1 Date of test............April 20, 1925
2 Location of plant............Memphis, Tenn.
3 Owner of plant......National Cotton Seed Products Corporation
4 Name of plant...Dixie Cotton Oil Company of Memphis, Tenn.
5 Mean outside air temperature from U. S. Weather Bureau..........74 deg. fahr.
6 Mean relative humidity from U. S. Weather Bureau..67 per cent
7 Mean barometer reading from U. S. Weather Bureau..........29.92 in. Hg
8 Duration of test............7 a.m. to 7 p.m.—12 hr.
9 Intervals of measurement............15 min.
10 Object of test: To determine the efficiencies of the various steps in the manufacture of cottonseed oil and its by-products at this plant near the end of a season's run, and to ascertain means for their respective improvements.
11 Maker and type of boilers..........Babcock & Wilcox Co., Stirling Class S No. 20
12 Maker of superheaters..Power Specialty Co., Foster superheaters
13 Maker and type of fuel-burning equipment..........Combustion Engineering Corp., Green chain grate

Description, Dimensions, Etc.

14 Number of boilers (all alike)............3
15 Number of tubes per boiler............360
(a) Number of drums per boiler............3
16 Boiler heating surface............3938 sq. ft.
17 Superheater heating surface............538 sq. ft.
18 Grate surface............78.6 sq. ft.
19 Projected area of passes, sq. ft..........first, 2310; second, 1375; third, 770
20 Baffle openings............42 in., 25 in., and 10 in.
21 Volume of combustion space............2565 cu. ft.
22 Setting of boilers............5 ft. $2^{15}/_{16}$ in.
23 Furnace volume per sq. ft. of boiler heating surface...0.65 cu. ft.
24 Ratio of steam-making surface to projected grate area......50.1
25 Cu. ft. of furnace volume per sq. ft. of projected grate area...32.6

Fuel Analyses

Proximate Analysis	(As fired) Per cent	(Dry) Per cent
26 Volatile matter	28.95	30.61
27 Fixed carbon	47.12	49.25
28 Ash	18.69	19.76
29 Moisture	5.24	.....
30 Sulphur	1.81	1.12
Total	101.81	100.24
Ultimate Analysis		
31 Carbon	61.60	65.00
32 Hydrogen	4.02	4.24
33 Oxygen	7.36	7.78
34 Nitrogen	1.28	1.35
35 Sulphur	1.81	1.91
36 Ash	18.69	19.70
37 Moisture	5.24	.....
Total	100.00	99.98

Ash Analysis

38 Moisture............0.2
39 Carbon (unburned)............16.0
40 Ash (incombustible)............83.8
41 B.t.u. per lb. coal as fired............10,764
(a) B.t.u. per lb. combustible as fired............13,240

Pressures

42 Steam pressure by gage at boiler, lb. per sq. in............175
43 Vacuum by mercury column, inches Hg:..........Turbine No. 1, 27.34; turbine No. 2, 27.77

Temperatures

44 Steam, deg. fahr............461
45 Superheat, deg. fahr............83.5
46 Feedwater, deg. fahr............206

Fuel

47 Fuel as fired: Boiler No. 2, lb. per hr............1925
Boiler No. 3, lb. per hour............1925
Boiler No. 4, lb. per hr............1692
5542

48 Dry fuel as fired: Boiler No. 2, lb. per hr............1824
Boiler No. 3, lb. per hr............1824
Boiler No. 4, lb. per hr............1603
5251

49 Fuel as fired per sq. ft. of grate per hour, lb., Boiler No. 2....24.42
Boiler No. 3....24.42
Boiler No. 4....21.53
50 Dry fuel as fired per sq. ft. of grate per hr., lb.:
Boiler No. 2............22.97
Boiler No. 3............22.97
Boiler No. 4............20.78
51 Total fuel as fired during test of 12 hr.: Boiler No. 2...23,100
Boiler No. 3...23,100
Total fuel as fired during test of 7 hr. 40 m.: Boiler No. 4...12,950

Total fuel as fired during 12-hr. test............59,150
52 Total dry fuel as fired during test of 12 hr.: Boiler No. 2..21,790
Boiler No. 3..21,790
Total dry fuel as fired during test of 7 hr. 40 min.:
Boiler No. 4............12,260
53 Combustion space per lb. coal per hr. as fired dry:
Boiler No. 2............1.45
Boiler No. 3............1.45
Boiler No. 4............1.63

Evaporation

54 Actual water per hour, lb............29,383
55 Total water for 12 hr., lb............352,600
56 Factor of evaporation............1.1127
57 Equivalent evaporation per hour, lb............33,114
58 Boiler horsepower for the three boilers............957
59 Readings of steam-flow meters in boiler leads; total steam, lb. for 12 hr.: Boiler No. 2............146,000
Boiler No. 3............150,000
Boiler No. 4............99,000
395,000

60 Per cent steam-flow meters were fast............11.48
61 Combustible in ash, per cent............16
62 Actual evaporation per lb. fuel (as fired, dry), lb............5.59
63 Equivalent evaporation per lb. fuel (as fired, dry), lb............6.39
64 Equivalent evaporation per lb. dry combustible, lb............7.79
65 Equivalent evaporation per sq. ft. of heating surface (3 boilers and 3 superheaters) per hr., lb............2.40

Efficiency, Etc.

66 B.t.u. absorbed per sq. ft. of surface (3 boilers and 3 superheaters) per hr............2411
67 Percentage of rating—three boilers together............80.9
68 Efficiency of three boilers, superheaters, furnaces and grates together, per cent............57
69 Efficiency of 3 boilers, superheaters, furnaces and grates based on 3 steam-flow meters, per cent............63.8
70 Kw-hr. of main turbines, 12 hr. run............17,300
71 Lb. of coal as fired per kw-hr. (at main turbines)............3.41
(a) Cost of coal per ton (freight, \$2.00; coal, \$0.80).....\$2.80
72 B.t.u. per kw-hr. (at main turbines)............36,705
(a) Cost of fuel for power per kw-hr............\$0.0047

Heat Account

	B.t.u.	Per cent
73 Heat absorbed by water and steam in boiler and superheater, per lb. coal as fired	6133	57.0
74 Heat loss due to moisture in coal	67.5	0.6
75 Heat loss due to water from combustion of hydrogen	463	4.3
76 Heat loss due to carbon unburned in ash	439	4.0
77 Heat loss due to stack, incomplete combustion of carbon, moisture in air, radiation and unaccounted for	3651.5	34.1
	10,764.0	100.00

78	Boiler horsepower used as heat for cooker and former	75	

STEAM ACCOUNT

		Lb.	Per cent
79	Water supplied boilers	352,600	100.0
80	Steam supplied turbine No. 1	91,054	25.9
81	Steam supplied turbine No. 2	199,920	56.7
82	Cooker (of meats)	16,200	4.6
83	Former (of meats)	6,000	1.7
84	Boiler-feed pump of Terry turbine	15,400	4.4
85	G. E. exciter turbine	13,080	3.7
86	Stoker engine	1,044	0.3
87	Steam ejector to keep basement dry	763	0.2
88	Steam pump to pump oil into tank can	1,200	0.3
		344,661	97.8
89	Unaccounted for	7,939	2.2
		352,600	100.0
(a)	Per cent of steam used in the form of heat		6.3

COTTON-OIL-MILL RESULTS

90	Lb. of cottonseed crushed in 12 hr.	344,000
91	Lb. of meats cooked in 12 hr.	137,280
92	Lb. of cake ground in 12 hr.	258,700
93	Lb. of cottonseed oil obtained in 12 hr.	28,262
94	Ratio of weight of meats to weight of seed, per cent	39.8
95	Ratio of weight of oil to weight of meats, per cent	35.2
96	Ratio of weight of oil to weight of seed, per cent	14.0
97	Kw-hr. per ton of seed crushed	100.5
98	B.t.u. per lb. of seed from coal as fired	1,843
99	B.t.u. per lb. of oil from coal as fired	13,136
100	Coal as fired per lb. of cottonseed oil, lb.	1.22
101	Maximum kw. demand per ton of seed per day of mill rating	4.25
102	Steam-turbine equipment load factor (ratio average to max. kw. demand)	0.542
103	Maximum kilowatt demand	1700
104	Investment load factor (ratio max. demand to turbine capacity)	0.68
105	Mean power factor	0.9
106	Annual load factor of mill	0.28

COTTONSEED ACCOUNT

(Lb. per ton of cottonseed)

		Lb.	Per cent
107	First linters	40	2
108	Second linters	85	4.25
109	Hulls	630	31.50
110	Cottonseed oil	300	15
111	Cottonseed meal	849	42.45
112	Unaccounted for	96	4.8
	Total	2,000	100.00

for the steam plant as well as the basic ratios used in the cottonseed-oil-mill business and a cottonseed balance.

The water rates of the boiler-feed pump turbines, exciter turbines, and the main turbines were secured from the test sheets supplied by their manufacturers, and from the small unaccounted-for loss in the steam account, accurate results must have been obtained.

As a result of this test it was found that only 6.3 per cent of the steam generated was actually used in the form of heat by the cooker and former of meats, that is to say, 22,200 lb. in 12 hours, or at the approximate rate of 30 boiler hp. Therefore no reason exists why cottonseed-oil mills may not be economically supplied with power from central electric stations.

The Federal Government reports 510 cottonseed-oil mills at the close of the 1925 season in operation, and 15,478 active gins. Less than 3 per cent of this high-load-factor and therefore desirable business is operated by central-station electric service, and it is virtually an untouched field.

Why, the author wonders, for it would be as advantageous to the cotton-oil industry as to the central station. Evidently the power companies have not as yet analyzed the cottonseed-oil power and heat requirements and presented the facts to the cottonseed-oil mills.

From the heat account it is seen that only 57 per cent of the heat in the coal appears in the steam. This is largely due to the fact that the traveling grates are too short, as even at the operated speed 16 per cent of the ash is unburned carbon. The setting of the boilers is 5 ft. $2^{15}/_{16}$ in., and of course should not be less than 12 ft., but nevertheless several manufacturers of combustion equipment offer the following guarantees with underfeed stokers: 76 per cent efficiency at 200 per cent of rating, 75 per cent at 225 per cent of rating, and 74 per cent at 250 per cent of rating. The steam requirements for 12 hours are 352,600 lb. for the present load, which corresponds to 213 per cent of the rating of one boiler at a guaranteed efficiency of 75.5 per cent with coal of 11,000 B.t.u. per lb.

Therefore two underfeed stokers should be installed, for they would earn 19 per cent per year on their investment after an allowance of 14 per cent for interest, taxes, depreciation, and insurance.

In addition to the two underfeed stokers each boiler should be equipped with a complete instrument board, and the firing floor with an illuminated large-dial master steam gage. Since the foregoing test was made upon that plant, at the author's recommendation the linter room, which contains six 200-ft. shafts operating at 700 r.p.m., has had 92 sleeve bearings changed to ball bearings, resulting in a saving of 160 kw.

A better steam cycle than the one used at this mill would have been to have extracted steam from the main turbines at the proper temperature to supply the cooker and former and to heat the feed-

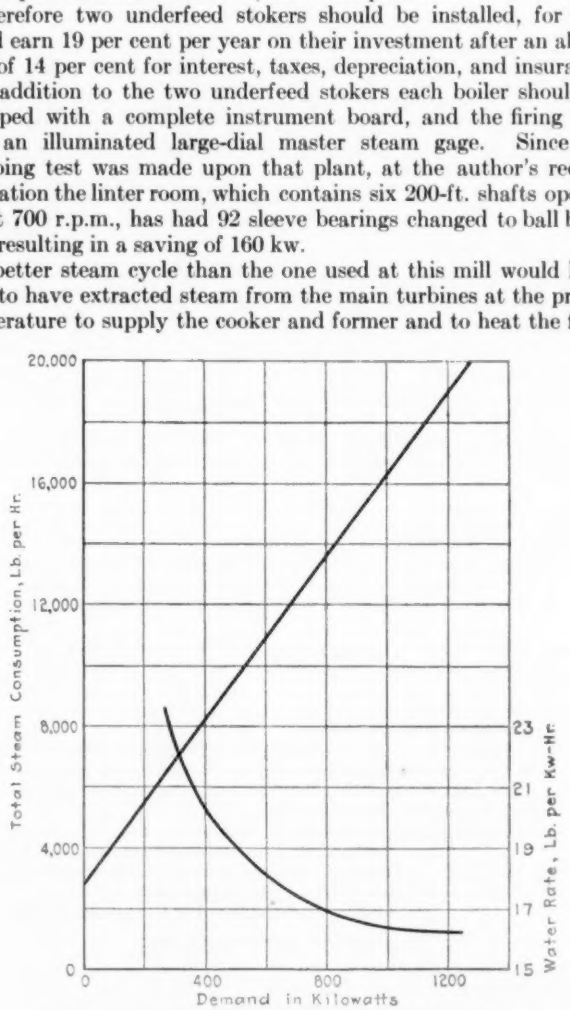


FIG. 4 TOTAL STEAM CONSUMPTION AND WATER RATE OF 1250 KVA. GENERAL ELECTRIC CO. TURBINE

(Pressure, 175 lb. per sq. in. gage; superheat, 100 deg. fahr.; vacuum, 28 in. Hg.)

water, to have used two ejectors with an inter- and after-condenser to obtain high vacuum from surface condensers, and to have used an open and a closed feedwater heater and thus with multiple-effect evaporators to have produced make-up water for boiler feed at a temperature of 280 deg. instead of 206 deg. fahr., at a saving of at least 13 per cent of the present fuel rate.

The 1924–1925 seasonal load factor of this the largest cottonseed-oil mill in the world was 28 per cent, but nevertheless the company, which owns 26 mills, had two other mills operating in Memphis.

The cost per ton of seed during the past season for one of these two mills was \$7.21, and for the other was \$9.00, whereas for the large mill under test the cost per ton of seed was \$6.28.

The differential cost in favor of the large mill in the case of the first of these other mills was \$0.93 per ton of seed, and in the case of the second, \$2.72.

The combined tonnage of these other two mills was 27,000 for the 1924–1925 season, hence had this additional quantity of seed been milled at the large plant its load factor would have been increased from 28 to 46.9 per cent; and as certain items of expense vary directly as the number of tons of seed crushed and others inversely as the output, the actual effective saving would have been at least \$43,000 for the season's run.

By a careful study of freight rates, cost of seed, etc., the operating expenses of each mill of the system may be referred to any other mill and the system so grouped that only those mills are operated which have a high load factor and low expense, and therefore give a lower cost per pound of oil.

Mechanical Gas Producers

Problems Arising in Substitution for Hand-Operated Producer of Completely Mechanical Producer in Which Manual Labor Is Supplanted by Mechanical Operations

By J. F. Rogers[1] and V. Windett,[2] Cleveland, Ohio

Until a comparatively recent date natural gas and petroleum served as cheap fuels in abundant quantities for large consumers such as are found in the metallurgical, glass, ceramic, chemical, and other heavy lines of industry. The cheapness and convenience in use of these fuels reacted on the price of the high-grade coals to keep them at competitively low prices. This golden age of fuels, however, has largely passed. The diminishing supply of natural gas has made its use in industrial furnaces economically prohibitive. The present practice of distilling petroleum to nothing but residual coke is cutting off the supply of fuel oil to a large extent. The more general use of producer gas as a substitute for these fuels has driven the consumer to use not only the higher grades of gas coal but also to widen his field of supply and to gasify coals of a lower calorific quality, as well as those unscreened "run of mine" coals with "fines" rising upward of 40 per cent of their weight.

Seventy years or more ago the Siemens brothers gave to the world their design of a stationary hand-worked gas producer. During many years and at the hands of many men this producer underwent development and improvement, appearing in its latest forms as the Duff, Swindell, Herrick, and other producers. Here and there and now and then tentative ideas were put forth indicating the need for a new type to supplant the stationary hand-operated machines. The rising scale of wages and growing scarcity of help, due in part to the hard, continuous, and disagreeable work in a producer house, stimulated the inventive genius of men familiar with gas making.

The successor to the hand-operated producer thus indicated is the completely mechanical producer, in which the manual labor formerly required in feeding the coal, working the fire, and cleaning out the clinkers and ashes is all supplanted by mechanical operations. The problems arising in this substitution are five in number, as follows:

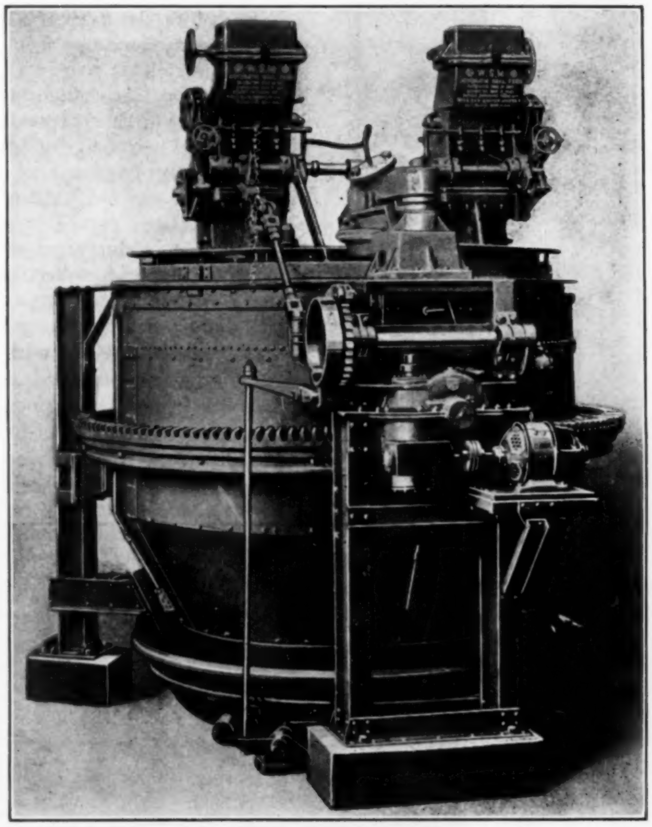
a To gasify a wide range of coals, including those less desirable from chemical and physical standpoints. This includes coals of high ash content and of low fusibility, and coals as shipped away from the mines without removing the "fines."

b To make a good gas, without deterioration in quality or quantity incidental to the cleaning of fires of the producer.

c To reduce the exhaustive, hard work of the gas maker, and also the amount of labor per unit weight of coal gasified.

d To increase the gasification rate per unit of cross-sectional area of the gasification zone. This must be done without appreciable sacrifice in the quality of gas. The increase in rate should be such that the investment charge for the more highly developed producer will be more than offset by its greater earning capacity. The increase in capacity should also effect an economy in the ground space occupied.

e To secure these results in a producer which, while mechanically driven, shall be simple, durable, and accessible in all of its operating parts. These parts should be made with sufficient precision to insure quick replacement without fitting or reshaping. The producer should be designed so that improvements as fast as developed may be applied to the machine without serious alteration.



W. S. M. Gas Producer Type L, No. 10

In the Earlier Days

The following short review of the prior art, will indicate some of the steps taken to solve the problem. Did space allow, it would be a pleasant duty to honor by name all those who have taken part in this march of progress, rather than to single out the few and mention their achievements.

One of the first problems thus attacked was the mechanical removal of the ashes from a stationary ashpan, the only kind then in use. Wilson, in England, in 1882 used a helical screw for this purpose. Wellman, in America, introduced in 1895 a reciprocating horizontal ash remover, and in 1898 used a series of revolving ash grate bars. Brooks, of England, in the years of 1883–1886 introduced the idea of a revolving flat ash plate. He discharged the ashes by using a revolving conical grate mounted on the flat ash plate. Taylor, in America, in 1889 substituted for the central conical grate a horizontal stationary adjustable scraper bar supported by the producer casing, which bar, projecting into the body of ashes caused them to be scraped off from the revolving table. These efforts were followed by those of Hughes, Wellman, Kerpeley, Chapman, Morgan, Wood, and others.

In the early forms the ashes were removed periodically. A serious objection to many of these devices was found in the disturbance to the making of gas consequent on the gradual building up of the body of ashes in the producer shell, followed by a dropping and breaking up of the fire every time the ashes were plowed out. The final solution was found in a rotating ashpan provided with a plow adjustable to remove continuously the ashes at the even rate at which they are made and delivered to the plow by scrapers depending from the rotating producer shell.

An equally important step was to cause a rotation of the producer shell containing the coal, combustion zone, and ash zone. The great value of this lay in the opportunity it gave to use a mechanical poker in place of the irregular and inefficient hand poking which is a feature of the stationary producer. One of the preëminent pioneers in producer development, the late W. B. Hughes, saw the opportunity and invented the oscillating mechanical, continuously working, water-cooled poker. The result was a great advance in the gasification capacity of the gasification zone, accompanied by a decided improvement in the quality of the gas consequent on a

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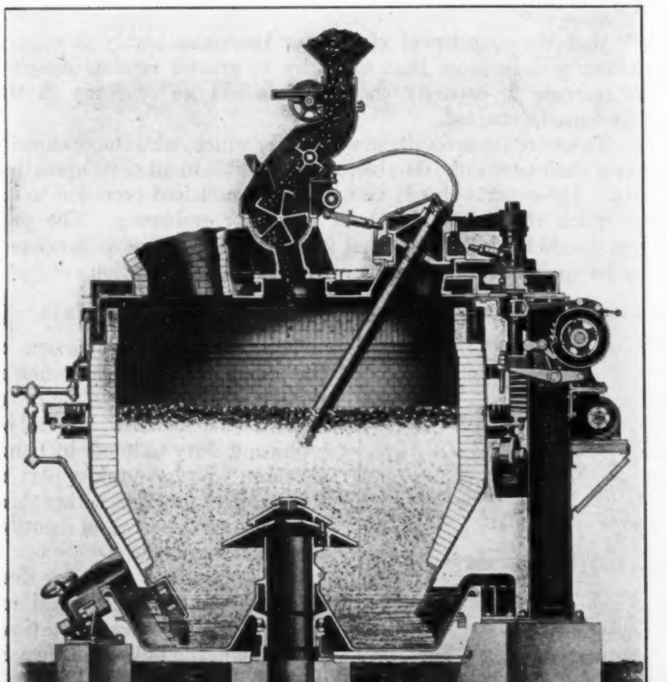
stabilizing of the gasification conditions of the combustion and distillation zones. Chemical analyses of the gases showed a decided lowering of the carbon dioxide and the practical disappearance of oxygen in the gas made.

Similar results have been sought through the action of other devices whose action depends on a combination having a rotating shell with moving mechanisms working on or in the fuel, even going so far in one direction as to consolidate or pack it down from the upper surface.



CROSS-SECTION OF W. S. M. GAS PRODUCER TYPE L, No. 10

In the latest and most successful application of the poker idea the poker oscillates in a curved path through the fuel bed between the producer center and the brick lining. As the poker is inclined at an angle toward the advancing fuel in which it works, and also at an angle approximately at right angles to this direction, it exerts a lifting action on the fuel. Its action on the fuel bed is threefold: first, it keeps the fuel loose and open for the ascent of the gases; second, it cleans the particles of incandescent fuel free from the ever-appearing ash so that the fresh incandescent carbon is in condition for rapid oxidation; third, it assists the descent of the ashes and clinkers from the gasification zone.

PIONEER WORK OF W. B. HUGHES

At the time when the late W. B. Hughes became interested in gas-producer problems he was chief engineer of the Pencoyd Iron Works. His first battery of producers was installed in this plant, and continued in successful operation for many years. Realizing the great future of the mechanical producer, Hughes' next step was to devote his entire attention to gas-producer design. For this purpose he took charge of this branch of the work of the Wellman-Seaver-Morgan Company in 1904, continuing in this work up to the time of his death in 1913. He was a pioneer in the development of the mechanical ashpan, plow, rotating shell, and poker, and early in his work saw that hand feeding was inadequate in amount and inferior in action, as well as burdensome to the operators. These troubles were overcome in the mechanical distributive coal feed which he presented to the Patent Office in 1908 for its protection. This feed spreads the coal over the fuel bed in a practically continuous stream proportioned to the gasification rate and regulated by a simple control device.

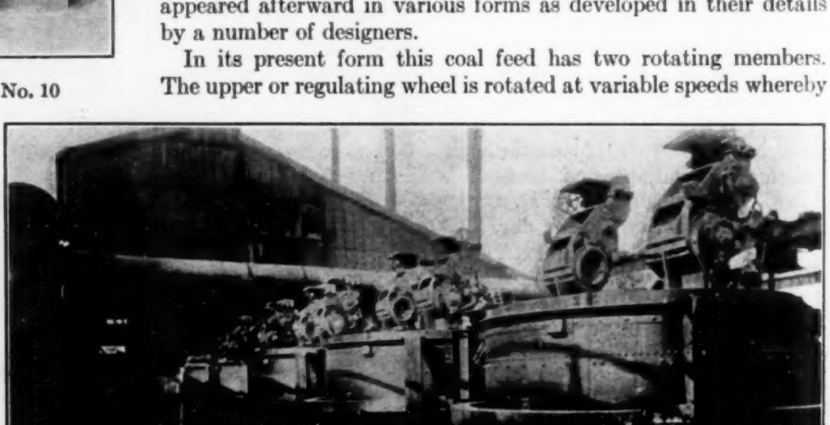
At the time Hughes laid down his work, he had brought about not only an appreciation of the requisites of an efficient producer, but had embodied them in the most efficient manner then available in the well-known mechanical gas producer bearing his name. The success of this type of producer is testified to by the fact that when it was superseded by its successor and lineal descendant in 1922 there were twelve hundred of these producers in active operation.

The high-water mark of Hughes producer operation, the authors believe, is found in the open-hearth plant of a large steel works. A gasification rate of 3470 lb. per producer hour, or 44.2 lb. of coal per square foot of producer area per hour in steady continuous operation, was reported by the then open-hearth superintendent. Fourteen producers supplied gas to seven open-hearth furnaces, working at about 20 per cent over their rated capacity of 100-ton heats. The quality of the gas was of as gratifying a character as the rate of this production.

Even before the days of a rotating shell and ashpan, attempts were made to get away from the generally used bell-and-hopper batch feeder. This required manual labor for operation. It delivered coal on to the fuel bed, in comparatively large quantities, after intervals of time depending on the fidelity of the gas man to his work. It required further manual labor to spread the coal over the fire by hand poking. Sometimes this was attempted, at other times it was not. All of these features are undesirable. As early as 1902 one company introduced a mechanical feed on the Fraser Talbot producers which they were then making. This consisted in a group of four vertical cylindrical cells, rotating in turn as charged over the discharge aperture into the producer and being at that time closed on top against escape of gas. Shortly after this they introduced the cylindrical multi-pocketed vane-wheel feed rotating on a horizontal axis. The idea thus taught to the art reappeared afterward in various forms as developed in their details by a number of designers.

In its present form this coal feed has two rotating members. The upper or regulating wheel is rotated at variable speeds whereby the rates of delivery of coal are adjusted to the varying demands for gas. The direction of rotation is against the descending coal, which lifts it and prevents choking in the bin spout. The lower five-pocketed vane wheel or valve revolving around a horizontal axis (as does the upper wheel) delivers the coal to the producer in small, regularly fed quantities, so that in effect the coal is fed into the producer in a practically continuous flow over the entire surface of the fuel.

Safety against breakage due to presence of "tramp" iron, etc.



ERECTION VIEW OF PLANT OF FIVE No. 10 GAS PRODUCERS

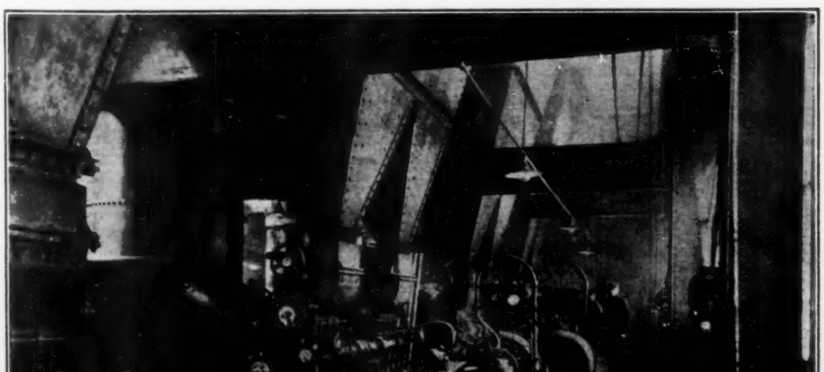
in the coal, is provided by transmitting the feed drive through a "shear" pin in the connecting rod.

This is the coal feed forming a part of the gas producer which has been developed with the help of many years' experience of Hughes producer operation.

Features of Type L Producer

Although at the present time there are a large number of producers in use in this and several foreign countries, the Type L producer is not as widely known as its predecessor. As much of the remainder of this paper relates to gasification experience gained with this machine, it may not be amiss to enumerate the salient features of this producer, on which its excellence rests. Starting at the top, the mechanical coal feed just described is used. The water-cooled top plate is of a single piece of rolled steel plate, so heavy and so reinforced as to obviate the need of a dome underneath of specially formed firebrick. The oscillating inclined poker has been found to be in advance of any other similar device in the results of its working the fuel.

A three-stage air-blast hood has been found superior to the three-arm blast spider and circumferential ring found in the Hughes and some other makes of producer, in that a free, unobstructed descent is possible for the ashes. The disturbance of the gasification conditions due to a tendency of the ashes to "arch" over from rib to rib is overcome. The ashpan is rotated on a large circular ball bearing through the friction of the ashes in the shell and ashpan. An interruption of the pan rotation of three variable periods, amounting to 21 deg. in all for each shell revolution, sets up a shearing action throughout the ash zone, which keeping the ashes in a loose, open condition, holds them in a favorable condition for the delivery to the fire of large volumes of air blast, at an expenditure of a very small quantity of steam to drive the turbine-driven air-supply fan, or as it is commonly known, the "turbo-blower." The use of a turbo-blower in connection with an air-blast saturation thermometer and an appropriate arrangement of steam piping allows the gas man to have perfect and independent control of the volume of air and steam entering the producer. The combination of these features affecting the gasification operations and the simplicity and suitability of the mechanical construction have resulted in a producer whose range of gasification has reached a minimum of



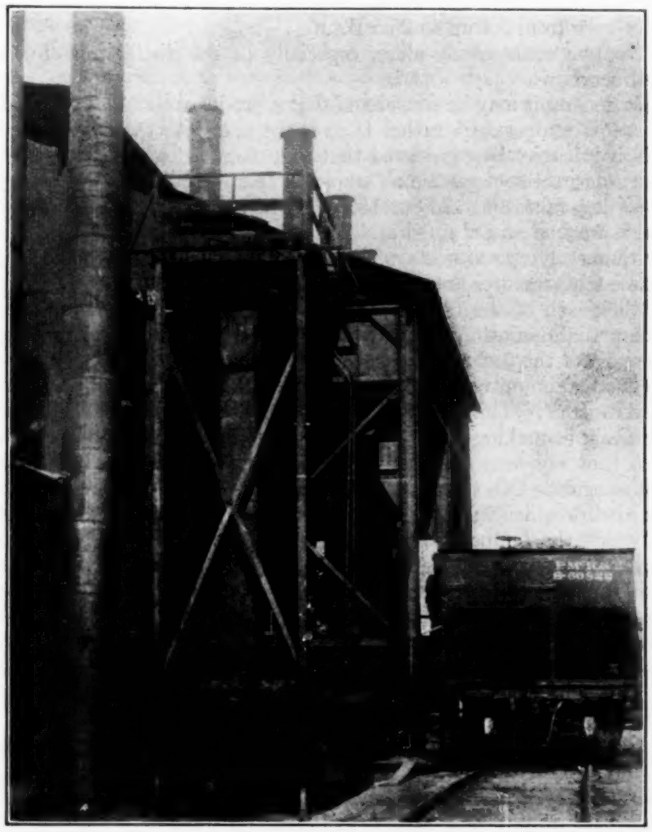
Operating Floor of Plant of Five No. 10 Gas Producers

12.0 lb. and a maximum of 84 lb. of coal per square foot of cross-section per hour, with the use of Eastern and central Western run-of-mine bituminous coals.

Gasification Experience

The question of gasification rates raises the question of the calorific value of the corresponding gas and its desirability in the furnaces where it is consumed. This again brings to the front the practical question of the cost of heating with producer gas as compared with the cost of heating with other fuels.

The calorific value of the gas is generally taken as the net B.t.u. at 62 deg. fahr. contained in one cubic foot of gas as sampled at the gas outlet or as near thereto as may be convenient. The usual



View of Gas House for three No. 8 Producers

and most approved method, in fact, the only one receiving the approval of the U. S. Steel Corporation's Chemists' Committee, is known as the "continuous" method. In this a small stream of gas is taken continuously from a sampling tube in the gas main near to the producer. The time of collecting each sample should cover a period of from ten to twelve hours. The importance of holding to the 12-hour period is that in practically all producers—every hand and many mechanical—every twelve hours the fires are "broken down," clinkers are barred off from the walls, and the ashes accumulated since the last cleaning are removed. This causes a drop of the fire through a height equal to that of the ash removed, with a loss of considerable coke from the incandescent zone into the underlying ashes. Such a disturbance causes a serious lowering of the calorific value of the gas, lasting sometime upward of an hour before a full recovery is made.

"Snap" samples taken in the course of five to fifteen minutes are indicative of producer conditions at the time taken, and by some are considered useful for this purpose.

A gas analysis and the calorific value calculated from it are about the best technical indications of gas-producer performance taken in connection with the gas temperature and ash analysis. At best a gas analysis as commonly made does not tell the whole story. The gas is collected in a container full of water at the start, and is analyzed in aqueous solutions of the reagents after being passed through a calcium chloride tube stopped with loose filtering cotton. Consequently the numerical results of the analysis take no account of the highly calorific tar vapors, which as a golden-yellow fog characterize gas made under

the best conditions. Another inaccuracy is the reporting of the hydrocarbon gases as CH_4 and illuminants. The net calorific values of one-tenth of one per cent in volume of CH_4, C_2H_4, C_2H_6, and C_6H_6, are respectively, 0.9, 1.5, 1.6 and 3.75 B.t.u. As the usual way of figuring the illuminants is to consider them all as C_2H_4 = 0.9 B.t.u., the resulting calorific value of a gas of say 0.6 per cent may vary from 5.4 up to 25.5 B.t.u.

No two coals gasify alike, especially in the distillation of the hydrocarbons.

In general it may be considered that a producer should be worked at a low temperature rather than a hot one. As these terms are relative, it may be considered that in a plant using hot raw gas in its furnaces a cool gas is one whose temperature lies between, say, 1000 deg. fahr. and 1250 or 1300 deg. fahr. In a plant where the gas is washed and cleaned and run at a lower gasification rate the customary temperatures are from 950 deg. fahr. to 1050 deg. fahr. These temperatures are of the gas as it enters the gas main just out of the reach of the radiant heat of the fuel bed of the producer. The actual operating temperatures in a producer are dependent on the part of the fuel bed under consideration.

The maximum temperature is found in the lower part of the combustion zone. This is due to the complete combustion of the coke, resulting in making CO_2 gas. This portion of the fuel bed merges into that above where the incandescent solid carbon reduces the hot ascending CO_2 to CO. This process absorbs heat to a temperature below which this operation stops. Then higher up is a stratum in which the temperature is stabilized. This heat as it rises and that of the stream of gas passing through the green coal on top is still further reduced by the absorption of heat in distilling the hydrocarbons and tar from the green coal. Should this final temperature remain higher than necessary, it breaks up the less stable hydrocarbon gases. The hydrogen released appears in the gas as such, while the solid carbon is lost as soot, which is deposited in the bottom of the flue and is lost.

For this reason, even in the absence of a pyrometer, the presence of much hydrogen in the gas shows generally that the producer operation is at a temperature destructive to the hydrocarbons. The other source of hydrogen is the steam used in the air blast. A high hydrogen from this source indicates an excess of steam, resulting in cooling down the zones of carbon dioxide too much. When this is the case, the CO_2 content of the gas is higher than good practice permits. "Good practice" may be defined as a condition of operation where all of the conflicting variables are balanced to the point of delivering into the furnace in which the gas is used a maximum amount of heat from the particular fuel then being used. One of the chief merits of a mechanical producer in which there is a continuous inflow of coal, even generation of gas, and continuous discharge of ashes at the same rate as they pass down and out of the combustion zone, is that the gas man, being relieved from arduous manual labor, devotes his energies and time to securing and keeping a balanced set of conditions best suited to the characteristics of the particular coal which he is using. That this is possible is shown by a maximum variation of resulting furnace temperature of only 12 deg. fahr., in a day's continuous operation in a glass factory using a medium-quality coal.

The improvement in the gas-producer art from the stationary hand-operated producer to the latest type of completely mechanical producer equipped with control gages and pyrometer may be summarized as follows:

	Type of Producer	
	Hand-operated	Mechanically operated
Rate of gasification per square foot of producer cross-section per hour	7.5 to 10.0 lb.	50.0 lb.
Quality of gas throughout the 24 hours of a day	Variable, from 140 net B.t.u. down to 80 B.t.u. during cleaning periods	Constant, average of 150–170 net B.t.u.
Coal gasified per man per day (all labor in producer plant)	3.25 tons	14–20 tons
Saving in number of producers for equivalent quantities of coal gasified per 24-hr. day	14 replaced by 5 13 replaced by 4 9 replaced by 4 6 replaced by 2 3 replaced by 1 2 replaced by 1	

Problems in the Textile Industry

Points on Fundamental Measurements in Cotton Mills, Engineering Aspects of Treating Textile-Mill Water Supplies, and on Mechanical and Material Research in Mill Management, Brought Out in Discussions at the A.S.M.E. Meeting in Providence

At THE Providence Meeting of the A.S.M.E., which took place during the first week in May, in Providence, R. I., Joseph A. Campbell[1] presiding, three papers were presented at a session held under the joint auspices of the Textile and Management Divisions of the Society, dealing with the subjects enumerated in the sub-title above. The discussion of these papers, which was voluminous, is summarized in what follows.

Fundamental Measurements in a Cotton Mill[2]

SIDNEY S. PAINE[3] presented a paper dealing with this subject, in which he enumerated the various fundamentals and pleaded for their more scientific measurement, as well as for a logical combination of the fundamentals that have already been measured.

Eugene Szepesi[4] contributed a written discussion in which he said that while the existence of scientific management was in general conceded by all in the textile industry, nevertheless it was still viewed more or less as an experiment which might be all right in theory but not in practice. The task of every engineer was therefore to use every opportunity to bring to the attention of the managers of that industry the fact that this development was real and applicable in every-day practice, and that there were tangible proofs available of the practical application of the scientific principles for every phase of management or operation of a textile plant.

The collective task of the members of the Textile Division was therefore, according to his opinion, the following: (1) The development of a machine through which such tangible information would be available to every member of the Division, whenever such information was needed; (2) a close coöperation of the members and a systematic registry of the particular facts in possession of the different members; and (3) a central point through which such information would be obtainable without divulging either party to the transaction. This would provide an opportunity for every one in the Division to obtain scientific facts, and assist him thereby not only to solve his particular problem on a scientific basis and indicate the right procedure of development, but also to assist the membership to put before the managing factors of a mill tangible information of what had been done and what could be done according to the principles of scientific management in solving a particular problem in which a plant at a time might be interested.

According to Mr. Szepesi's personal investigations and careful tabulation there were over three thousand plants in the textile industry today in the United States which, by the magnitude of their operations, should be operating under the principles of scientific

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[2] Published in Mechanical Engineering, May, 1926, p. 432.
[3] President, Textile Development Co., Boston, Mass.
[4] Szepesi Industrial Organization, Boston, Mass. Mem. A.S.M.E.

management; but there were less than two hundred textile plants in the United States where these principles were partially employed, and he doubted if it would be possible to list more than twenty textile mills operated entirely according to the principles of scientific management.

Charles T. Main[5] wrote that early in his engineering work in connection with textile mills he began to accumulate all the information he could with reference to the organization of different mills, and found that there were apparently no two mills with the same organization, although many were producing the same numbers of yarn.

The drafts in the different mills varied enormously, but it seemed to him then that there must be some general relation that the draft should bear to the weight of sliver or roving, which, if approximately followed, would give the best results. Later he had established a series of tables for different counts of yarn, showing weights, drafts and numbers of the various machines required for the different operations for the different values and quantities for ordinary yarns. He mentioned this as one illustration of an attempt toward standardization of organization and operation.

It was a rare thing to find in any room prepared tables showing proper speeds, weights, drafts, twists, etc. Such carefully prepared information, if followed, would be of considerable benefit to a mill.

There were in this country several research laboratories, and an attempt had been made to affiliate them in some way so that whatever was developed that might be for the common good of the industry, could be made useful to all without duplication. If some central control for research could be established, it would be of great benefit to all.

If our textile mills were to be prosperous, they would have to produce fabrics of a character which the public would buy, and they would have to be produced at a cost so that they could be sold at a price which would be attractive. Such work as the author was doing, and other work of research, standardization of organization and production, so far as it could be done with such rapid changes in design as seemed now to be necessary to satisfy the public, would be helpful to the industry.

H. P. Kendall,[6] who opened the oral discussion, said that in his opinion the movement which the author represented was the most significant one that had taken place in the textile industry within his generation. There was nothing new in the principles involved, it was simply the old idea of Taylor, and illustrative of what could be done in manufacturing by a person with an engineering approach and with engineering methods—what could be done by careful study of the details of manufacturing.

His company has had experience in one or more of their mills in the South in working along the lines that the author had described. They had started to class their cotton more carefully and more accurately at the first of the machine operations in the mill, and carried the work right through to bring each machine up to standard: proper speeds, twists, drafts, etc., at the same time educating the employees to a feeling that there was something new that could be developed out of this study in which they would share in the savings of, and thus securing their coöperation. Months had been spent in bringing up old mills to standards that would insure a proper output, and the education of the employees had been carried out successfully.

Today the margin between profit and loss in industries generally, in Mr. Kendall's opinion, was made up of the little savings that could be effected only by good management.

J. A. Willard,[7] commenting on the author's statement that very many of the mill operating conditions were determined on a basis of personal opinion, said that he had had his mill experience under an old Scotchman who would have nothing to do with apparatus for controlling humidity, claiming that he had been brought up as a weaver and could smell just as soon as he entered the weave room whether humidity conditions were correct or not.

Mr. Willard wondered whether the author had done any work in connection with the recent developments in the cleaning of cotton. There were a number of cleaning devices on the market which were supposed to raise low records on cotton from two to three grades. It seemed to him that this was a very important development and one that should be pushed very aggressively by mill men, because it offered a possibility of using for cheaper grades of cotton goods a lower grade of north Texas and Oklahoma cotton, which might be of considerable value for lower grades of goods and the coarser counts.

Mr. Willard had been particularly interested in the author's statements in regard to the machine standards that he had set up, and had wondered if he had gone beyond the point of setting machine standards; that was, whether he had set labor standards as well and employed any of the incentive methods mentioned by Mr. Kendall. He felt that a great deal could be done in the training of workers, particularly the fixers and overseers, and also in devising an effective follow-up checking system to determine the fact that they had the right gear on. He wondered whether the author had been able to apply labor incentives similar to those developed by Mr. Gantt in connection with getting maximum production out of machinery after it had been standardized. The standardization condition, he believed, was absolutely essential first.

McRea Parker,[8] said that at the last annual stockholders' meeting of his company a gloomy picture had been painted to the effect that there was twice as much textile machinery in the United States as was needed to take care of the demand for textiles, and the only way out of this situation that had been suggested so far was that a number of larger mills should get together and form a large combination, eliminating some of the poor factories in the merger and running the most efficient.

It was one thing to set up standards of development by experiments, but quite another to maintain them, and he wondered whether some method could not be devised to maintain the product at the end of each process—to have some way of checking it at those points—better than was done at present.

The manufacturers, Mr. Parker thought, ought to get together. They ought to collectively employ the services of the best consulting engineers available and give each other the benefit of what they learned. More plant engineers were needed in the textile factories; and this would aid the work of the consulting engineers, otherwise the latter would become an irritant there. Managers were far too prone to believe the overseer and let things go the way they had always gone. But this could not be done during the next twenty-five years.

The author, in closing, said in replying to Mr. Willard that he believed many of the machine companies had developed cleaners that would definitely make it possible to use a lower-grade cotton; and that the cleaners now available, that cleaned without beating, removed the necessity of having so much beating in the pickers.

As to whether the tasks of the help had been standardized, he would answer very definitely, yes. He believed that it was now possible to predict the loom stoppage that would result, assuming corrected machine conditions throughout the mill. He had been working on that for some time and believed that he had a combination of data in the form of curves by which such predictions could be made. He also believed that on any construction of cloth a standard could be laid that would be very close to what the mill could do, on the number of looms a weaver could run and the work she could get off.

Regarding inspection, the author agreed that minor officials as well as major officials were inclined to let things take care of themselves. He believed that a loom fixer for instance, starting down with the fixers, should inspect every part of the loom at regular intervals. He did not think with the many machines used in the mills that there would ever be put into operation a system of running all the product of every machine through an inspecting room, but he did believe that the duties of fixers, second hands, and overseers could be functionalized so as to give a virtual inspection continually, which was exactly what was needed more than anything else; that was, assuming that machine conditions had been standardized.

As to labor incentives, the mills that he had known had established piece rates and two of them paid a bonus when a certain percentage of efficiency was exceeded. But he did not think that the matter

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[8] M.E. and E.E., Cleveland Worsted Mills, Cleveland, O. Assoc-Mem. A.S.M.E.

had been worked out as Mr. Gantt or any of the other engineers had done in other industries.

Engineering Aspects of Treating Textile Water Supplies[9]

THIS paper, by Howard L. Tiger,[10] discussed impurities in water and their removal; chemical control of coagulation; chemical feeds; settling tanks and filters; water softeners; choice of equipment; sources of contamination; relation of water to process; adjusting process work to water; etc.

Horace G. Killam[11] wrote that he wished the author could have emphasized more strongly the importance of an adequate settling tank for the proper removal of organic matter. When considering the installation of a filter plant, many mill engineers and mill managers no doubt felt that the settling tank was an added refinement put in at considerable expense to satisfy the whims of the filter-plant salesman. His company had had something of that feeling when they had investigated the question two years ago. They had decided, however, to include a settling tank in their layout, and felt now that they had been right in doing so.

This settling tank was a steel tank about 40 ft. high and 30 ft. in diameter, with proportioning chemical feeds similar to those described by the author. It was found that the color of the raw water at one time was reduced from 50 p.p.m. to 35 p.p.m., and turbidity from 26 to 15, merely by chemical treatment and settling. In other words, approximately one-third of the filtering was accomplished before the water reached the filters themselves.

A visual indication of the effectiveness of the settling tank was afforded during the operation of sludging. This was accomplished daily by opening three valves in the bottom of the tank and permitting the sludge to flow to the sewer. The quantity of sludge removed in this way seemed equal to, if not more than, that removed by backwashing the filters themselves.

Another point which had been brought out by his company's short experience with filters was the immediate increase in the amount of coloring matter in the filtered water when they exceeded the designed capacity of the plant. This indicated the importance of designing a filter plant for the peak load, or providing for adequate clear-water storage.

F. N. Speller[12] and C. R. Texter[13] submitted a written discussion in which they said that the treatment of water for either domestic or industrial purposes frequently introduced complications which were entirely unanticipated and unforeseen. The very process of overcoming one difficulty might activate or accelerate some other. Among these evils was that of corrosion, which was generally present wherever liquids came in contact with metals, but which was often much accelerated by water treatment.

Without entering into a discussion of the theories or the different forms corrosion took, it was safe to say that as a general rule, soft waters were much more corrosive than hard waters. Of course, as was the case with most rules, there were some exceptions. For instance, many of the water supplies in Florida cities were very hard, yet they contained so much sodium chloride and hydrogen sulphide that they were very corrosive.

The contamination and pollution of many water supplies caused by the centrallization of industry and the concentration of population had made water filtration a necessity both for municipal and industrial use. Incident to efficient filtration was the use of aluminum sulphate, which, upon reacting with the bicarbonates contained in the water, liberated free carbon dioxide. This increased the hydrogen-ion content of the water and made it more corrosive by tending to dissolve or prevent the formation of certain protective coatings on the metal. Other protective coatings due to matter in suspension in unfiltered water were, of course, not formed after these materials had been eliminated by efficient filtration.

Hard waters, as had been stated, were usually less corrosive than soft waters. This was especially true if the hardness was caused by calcium bicarbonate, which often built up such an efficient lime coating in pipes as to materially protect the metal. The opposite effect was caused by a very soft water. Soft waters contained little or no lime and were often free from other dissolved scale-forming material, and, therefore, since no protective coatings were deposited, the water was more free to attack the metal.

Consequently it was found that the treatment and filtering or softening of some waters, which were absolute necessities for textile washing, were often the accelerators of an evil which in itself was very detrimental. Not only were pipes and tanks corroded, but, more serious still, the colloidal-iron compounds in certain waters were precipitated upon fabric with injurious results. The writers did not intend to imply that water softening or filtration should be in any way discouraged—on the contrary, such treatment was unquestionably a great aid to the laundry and textile industry. Nevertheless its advantages had been counteracted in some cases by the discoloration due to the increased rate of corrosion after such treatment. Fortunately certain additional measures could be taken to reduce or eliminate entirely the red-water nuisance.

Oxygen removal, they wrote, was of course the most complete method of eliminating corrosion, but the cost of this process was sometimes prohibitive where large volumes of water were involved, especially if the water was to be used at normal temperature. Efficient deaerating apparatus were now on the market.

Corrosion could often be retarded sufficiently by treatment with certain reagents, particularly if the corrosion manifested itself only as dissolved iron and not in the form of serious pipe disintegration. Baylis[14] had shown that in the city of Baltimore, Maryland, corrosion had been very materially reduced by the proper use of lime after filtration to neutralize the free carbon dioxide. The use of alum in the Baltimore filtration plant resulted in an increase in free carbon dioxide from about five parts per million in the raw water to ten and twenty in the filtered water. With this increased carbon dioxide content it had been found that "rusty" water had become a very serious problem in Baltimore until the proper amount of lime had been added after filtration. The use of lime naturally increased the hardness of the water, which would be objectionable for some textile work. In this event sodium hydroxide might be used to secure the desired equilibrium between the pH value (alkalinity) and the hardness expressed as $CaCO_3$.

Where water had been softened to "zero hardness," corrosion was sometimes increased considerably and iron in the water became an actual menace to successful textile washing. It was true that the presence of iron in the water could be prevented by the use of pipes made from certain non-ferrous metals, but almost all of the ordinary metals were dissolved in water, and many of them were injurious to textile materials such as rayon. Furthermore the high cost of many metals prohibited their use in industrial plants.

With the use of steel and iron pipe, it had been found that corrosion with its attending red water could usually be prevented economically by the use of about 10 to 20 p.p.m. of silicate of soda, which not only neutralized acidity, but caused an insoluble deposit to be formed slowly upon the walls of pipes or tubes. It might be applied either as a solid or a liquid at some convenient point near the heater or in the cold-water line. Space did not permit a detailed description of such after treatment, but it had been successfully applied by the writers in the case of certain zeolite-softened waters. Another possible remedy for the red-water trouble which seems to have considerable merit was the use of steel pipe lined with cement, lead, or rubber (vulcanized).

This discussion was presented merely to show how ramified was the subject of water treatment, and particularly to emphasize the importance of seriously considering the corrosion angle to the situation. It was only by considering all of the related factors and truths that one could successfully cope with a problem and keep it under control.

McRea Parker,[8] who opened the oral discussion, said that the matter of water treatment was something that had been long delayed in the textile industry and he thought the number of plants that were treating water was comparatively small.

The company which he represented, the Cleveland Worsted Mills, had used water treated by the zeolite process for something

[9] Published in Mechanical Engineering, May, 1926, p. 435.
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[11] Chief Engineer, The U. S. Finishing Company, Providence, R. I.
[12] Metallurgical Engineer, National Tube Co., Pittsburgh, Pa. Mem. A.S.M.E.
[13] Metallurgical Department, National Tube Co., Pittsburgh, Pa.

[14] Am. Water Works Assn. Jl., vol. 9, no. 3, May, 1922, pp. 408–417.

over a year, and had facilities for treating a million and a half gallons per day. The use of this treated water had done everything that the company had anticipated. It was one of the finishing plants that thought it had an ideal water. It had a clear-water lake of its own, and originally when it used that lake water it was of only 4 deg. hardness, but of recent years, the hardness had gradually increased. Sometimes there was a hardness of from 8 to 10 deg. The principal thing was the fact that the hardness varied. If it stayed at 4, 6, or 8 deg. the company could, perhaps, hit it approximately right with its formula. The dyer and finisher knew they must add different amounts of chemical treatment here and there to offset the hardness, and the splendid thing about a treated water was that it could be reduced to a constant chemical content.

Mr. Parker did not mean to say, however, that softened water would eliminate all troubles. There was generally some fly in the ointment, and it had been found necessary to change some of the processes slightly to fit the work to the new order; but that had been a matter of small detail and the company felt very happy that it had gone over to this system of using treated water.

One of the points that the author had brought out in his paper, and one on which Mr. Parker was most skeptical, was the ability of the common millhand to run the apparatus. His company had a very large one, six horizontal units 9 ft. in diameter and 25 ft. long. They pumped directly through these units from the lake, and from the units the water went into a standpipe, which acted as a soft-water storage. He had selected the man to run this plant, a farmer who lived in the neighboring territory and who had had no experience around a mill, and had succeeded in training him while the erector was on the job, and he had run the plant ever since. The economy of the plant, the materials used for the amount of water used, had borne out their predictions.

E. H. Marble[15] asked the author what experience he had had with some of the southern plants, taking water, as they did in some cases, from the river or from a muddy creek. Was it necessary to use filtration first and chemicals afterward? He had found in several cases in the finishing of fabrics, particularly some of the finer white goods, that there had been great trouble at different seasons of the year, such as the spring and the summer, owing to the inequality of the composition of the water.

W. S. Wheeler[16] said that his company used zeolite softener, and he would like to hear the author discuss the removal of iron, for they had had trouble with the formation of iron spots in some of their processes.

C. S. Makepeace[17] asked the author to touch on the oil question. The oil on the roads after a heavy rain would get into the water, and in making a bleach of fine white goods it had been found to be very objectionable.

The author, Mr. Tiger, in reply to Mr. Marble's question concerning the treatment of waters that varied with the seasons, said that that characteristic was common to practically all surface supplies, and that he had had similar experience throughout the South. Among the factors which must be considered when choosing a water-purification plant he had mentioned that a sample of the water must not only be taken at the time during which the problem was considered, but that water must be considered in its various conditions throughout the seasons of the year, and the plant should be installed to treat the worst water during any season of the year.

The specific method of treating these colored surface supplies was to apply the alum coagulation to the water, allow it several hours to settle in the settling tank, and then pass it through the filters. That part of the process, if properly applied, would completely remove the turbidity and color. Then if there were any hardness salts present—calcium and magnesium salts—they should be removed subsequently by means of the zeolite softener. The water might be perfectly clear and colorless and yet contain a large amount of hardness salts, which would cause the trouble common to them—insoluble soaps and insoluble compounds with dyestuffs and scale in the boilers. To summarize: For the removal of turbidity and color one should use coagulation and filtration, and for the removal of the residual hardness, that was, all the hardness present in the original supply, a zeolite softener. With the increase in the movement for installing mills throughout the South he had observed a distinct increase in the number of water-supply questions that had come from that section of the country, as well as a rapid increase in the number of plants installed for purifying these textile supplies.

Mr. Wheeler's question about iron removal opened up a broad subject. It was difficult to give a clear answer to this question without knowing the conditions. For example, a water free from iron might be delivered to the softening plant, and that water might be contaminated with water in the pipe lines or vats. He had even seen cases in a high-grade silk-hosiery mill where the water delivered to the plant was absolutely free from impurities but was delivered to concrete vats in which the hosiery was bleached. In that process the bath was acidified and the acid leached iron out of the concrete, thereby producing a flat yellow instead of a clear white. Similar cases had been observed where plants were not particular to flush pipe lines when the water had been allowed to lie in them for any length of time. Proper flushing was a matter that should not be overlooked, and he had always advocated that the job be assigned to one man who came on a half-hour before the rest of the employees in the mill and who should be held responsible for flushing out the lines until the water was clear when taken from them. That was the only test needed for that kind of iron.

As to the removal of iron from the raw water, if it was present in any large quantities the zeolite softener should not be depended upon for its removal, but other adequate means should be employed. If the iron was present in a surface supply, coagulation and filtration would remove it. If it happened to be a well water, different treatment was required, because in well water iron was present as an inorganic compound and would require aeration followed by filtration in a specially designed filter.

Mr. Makepeace's question about oil removal, said the author, brought up another type of treatment that was required. The subject was so big that it was impossible to touch on all the problems that occurred, even in the textile industry itself. Oil removal could be carried out completely, and there were a great number of plants doing it at the present time. The general method which would be used in a case of that kind was to coagulate the water with alum, and then allow sufficient time for the reaction to take place, after which the water would have to be filtered through a specially designed oil-removal filter. That filter had to be equipped also with means of cleansing the filter bed after it had collected the oily impurities, because the oil that got into the water was very adherent, and if there were not adequate means for cleansing the bed, the sand would become coated with this material and be prevented from functioning properly thereafter. He had found a very effective method was to use a tank of alkali, which was periodically injected into the sand bed, and the entire sand bed within the filter itself, and without any necessity of opening the filter and removing the sand, could be boiled with the alkali solution, thus removing the coating of oily materials and making the sand bed ready for filtration again.

In designing a filter of this type it was necessary to consider the size of the sand grains very carefully, and these details were matters which had to be decided for each individual case. He had run across a case recently in a Michigan mill where they were treating the water supply. It happened to be a woolen mill that was making a great amount of whites, and had been having a trouble not uncommon in woolen mills, that was, they were unable to get a clear white. He had finally traced the matter to the improper functioning of the sand-filter plant, which again was directly traceable to the size of the sand grain. That detail, which was seemingly unimportant and not considered in many cases, really should be and must be considered for each individual case.

Messrs. Speller and Texter were quite correct in stating that many factors must be considered when installing water-purification equipment. They mentioned specifically the corrosion of pipe lines which resulted when the free CO_2 was increased by alum treatment and the protective coatings resulting from suspended matter and hardness were eliminated by the removal of these impurities.

As mentioned briefly under Sources of Contamination in the

[15] President, Curtis & Marble Machine Co., Worcester, Mass. Mem. A.S.M.E.

[16] McCallum Hosiery Co., Northampton, Mass.

[17] Architect and Mill Engineer, C. S. Makepeace & Co. Life Mem. A.S.M.E.

paper, it was just as necessary to make certain that the process water was not contaminated as it was to remove the impurities initially. Long experience with the use of clear, colorless water, free from hardness, in textile plants had proved that the "red water" nuisance could be effectively avoided when the following factors, mentioned in the paper, were given due consideration:

1 Neutralize with alkali in the proper amounts and at the correct point in the system to reduce the aggressive quality (high CO_2 and low alkalinity) which might have been due to a low original pH value or to alum coagulation;

2 Experience showed that ordinary flushing, which was always necessary when water of any quality had been lying in the line for any length of time, was a sufficient precaution with properly treated, neutral, clear, colorless water of zero hardness.

Mr. Parker,[8] at the close of the author's remarks, said that he thought he could add something that would help Mr. Wheeler in eradicating iron. The author had stressed the matter of finding the source of iron and getting rid of the cause. His company had had the experience of pumping water through a 14 in. cast-iron line approximately $2^1/_2$ miles long. In the fall they had experienced considerable trouble with iron stain. They had studied the matter and had developed the theory that the excessive iron stains in the fall were due to the fact that the growth of vegetation in their lake began to decompose in the fall and gave rise to considerable carbonic acid gas in the water, and that this solution of carbonic acid gas would corrode the iron and produced the iron stains. They had begun by drawing off the water in this long pipe line the first thing every morning, drawing it back into the lake at a point where it would not affect the intake, and this procedure had largely corrected the trouble. They had picked up a feeder in their place and put in an outlet whereby they could regulate the level of the lake, and last year in the middle of the summer, at the time this vegetation was expected to decompose, they had drawn the level of the lake down so that there was exposed to the air a shore line of 14 or 15 ft. that was full of this growth, and had let it decompose in the air, after which there had been no further trouble.

Mechanical and Material Research in Management[18]

The third paper to be presented was one bearing the above title, in which Thayer P. Gates[19] gave particulars regarding a method for locating hidden wastes in textile manufacturing that had shown marked results, and of its application in a mercerizing problem.

J. D. Robertson[20] asked whether there should be enough cloth in the pad so that it would be in the caustic for 30 seconds; whether or not it was the usual custom to put the spray, say, about 10 feet from the end of the frame; and what portion of the frame length should be used to bring the fabric back to the gray width. Also, using dry cloth, whether it did not cost more to dry it than the gain amounted to when using the exact strength of caustic. He believed that very much greater luster was obtained with the wet cloth, as well as very much greater shrinkage.

E. H. Marble[21] inquired whether there had been any investigation of the character of the shrinkage of the different types of cotton. In some grades it took longer than the 30 seconds mentioned in the paper to get the greatest shrinkage. In many cases there was practically no shrinkage whatever in fabrics. It was an expansion or enlargement of the individual fibers and threads which caused a contraction, and this could easily be proved by watching a projection of the fabric on a screen.

H. M. Burke[22] asked whether, when cloth was passed through the mercerizing frame without passing through a series of heavy nibs, it was not a fact that the effect of the moisture on that cloth would be the same as that of a film of water that was incompressible and resisted the caustic; and whether the application of the author's empirical formula would not require a certain type of equipment to insure that saturation would take place in 30 seconds. Also, whether it was not just as difficult to follow the author's percentage solution as to employ the Twaddell hydrometer.

Replying to Mr. Robertson, the author, Mr. Gates, said that the time the cloth was in the caustic before it received its first wash was 30 seconds; some of the cloth was in the pad and some in the frame. He had never seen a spray used in mercerizing before the cloth had been brought at least close to the gray width, and this, at a slow speed would require about 10 feet of frame length. Under the new method the cost of mercerizing had been reduced by a much greater amount than the cost of drying. A better luster should be obtained on wet unboiled goods than on dry unboiled goods provided the caustic strength could be maintained; and dry boiled goods gave a better saturation and better luster than wet unboiled, although the shrinkage was greater in the latter.

As to the shrinkage concerning which Mr. Marble asked, the author said that he had seen the process described in the paper carried out on Sea Island, Peruvian, and Indian cottons, as well as on American cottons ranging from that used in making the cheapest kind of scrims to the best grades, and that in all cases 30 seconds had been sufficient time for saturation. In regard to shrinkage, when a piece of cotton cloth or a piece of yarn was dipped into caustic, whether the fiber shrunk or expanded, there was nevertheless a very pronounced contraction.

Taking up Mr. Burke's comments, the author said that by pretreating the cloth a higher luster would be obtained. He was measuring luster from shrinkage, and it had been shown that the greater the shrinkage, the greater the luster. As to controlling the strength of the caustic, that could not be left to the operator, because chemical appliances had to be manipulated, and this was generally done at the main tanks by the foreman.

[8] Published in Mechanical Engineering, June, 1926, p. 579.
[19] Textile Specialist and Consulting Engineer, Providence, R. I. Mem. A.S.M.E.
[20] Mount Hope Finishing Co., North Dighton, Mass.
[21] President, Curtis & Marble Machine Co., Worcester, Mass. Mem. A.S.M.E.
[22] Plant Engineer, Mount Hope Finishing Co., North Dighton, Mass. Mem. A.S.M.E.

El Arte de los Metales

The Engineering Societies Library has to thank E. L. De Golyer, Vice-President of the American Institute of Mining and Metallurgical Engineers, for an unusually interesting addition to its collection of early engineering books. Mr. De Golyer's gift is a copy of the rare first edition of Albaro Alonzo Barba's "El Arte de los Metales," published in Madrid in 1640, the earliest work published on American metallurgy.

Barba was an Andalusian, probably born on November 5, 1561, who became a priest and was sent to America prior to 1590. In 1615 we find him in Upper Peru (Bolivia), where he served various parishes for twenty-five years or more. He also was interested in mining, and speaks in his book of locating a vein of silver and erecting a mill. He claims to have discovered, in 1690, the method of pan amalgamation, and to have applied it successfully on a large scale.

His book is chiefly a detailed description of the metallurgical methods used in Peru, a topic on which his years of active work made him an authority. For many years it was in great demand and translations into French, German, and Italian were published. In 1670 the Earl of Sandwich, then Ambassador Extraordinary of Great Britain to Spain, published an English translation of the first two books of Barba's work, but his lack of technical knowledge made the translation of little value, and no adequate English translation appeared until 1923, when a translation by Messrs. Ross E. Douglass and E. P. Mathewson was published in New York.

Copies of the first edition of the work are extremely scarce. The writer has never seen one catalogued for sale, while Douglass and Mathewson state that they could locate but three copies, all of which were in the British Museum. Mr. De Golyer's copy is the fourth to come to his attention.

Among the various editions of Barba's book another of special interest to Americans is one in German, which was published in 1763, at Ephrata, Pennsylvania. That the publication of a German translation, in Pennsylvania, over a century after the book was written, should appear a profitable publishing risk, is an evidence of the great esteem in which the work was held. The Engineering Societies Library is so fortunate as to possess a copy of this edition, in the original binding.—Harrison W. Craver.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICAL ENGINEERING (See also Transportation)

A Tailless Airplane

THE purpose of designing a tailless airplane was to secure a machine that would be safer in flight and practically free from accidents caused through lack of control.

As a basic conception the author and designer of the plane under consideration advances the simple condition that the forces acting on an airplane in steady flight consist essentially of the weight acting vertically downward, and the total resultant air forces acting vertically upward through the center of gravity. In order to trim at different speeds, the total air-force resultant must pass through the center of gravity (C. G.) at more than one attitude. Imagining for simplicity that the C. G. is on the chord, and taking the center of pressure not as that of wings alone but of the whole system of surfaces after the elevators have been set to trim, the center of pressure (C. P.) must remain stationary with change of attitude if the machine is to have any speed range. This stationary C. P. is the fundamental requirement on which the author fixes attention.

Control surfaces on an airplane perform four duties: (1) they trim the airplane at different speeds, being set to such an attitude as to insure the C. P. coinciding with the C. G.; (2) they trim the airplane with varying load distribution; (3) they correct disturbances caused by gusts; and (4) they secure the power of maneuvering.

In regard to the last function, Captain Hill points out that the shift of C. P. required for maneuvering is very small, and the angle through which control surfaces must be moved to produce such a shift is also very small. Nevertheless small control movements do not suffice to produce rapid maneuvers, because as soon as the airplane begins to turn, the C. P. moves as the result of that turn in such a way as to counteract the effect of moving the control. Thus the control movement actually needed to maneuver is mainly required to trim the airplane while turning, and only to a small extent to produce the angular acceleration of the actual maneuver. Thus the last item in the duties of controls is partly already covered by (1) trimming, and the only new duty involved is that of producing acceleration.

The last three functions of the controls present little difficulty. Correction for varying load distribution has to be watched, but can usually be secured without trouble. It will be generally agreed that if rapid maneuvering is possible, gust disturbances can be dealt with provided great instability is not present, and the provision of the angular accelerations needed for maneuvering requires only small control movements. Thus the problem of control resolves itself essentially into the maintenance of trim, and Captain Hill argues that the problem is solved when a stationary C. P. throughout the range of straight flight and the rate of maneuver required have been achieved—provided gross instability is avoided. (Paper by Capt. G. T. R. Hill read before the Royal Aeronautical Society, Apr. 22, 1926; abstracted through *The Aeroplane*, vol. 30, no. 17, Apr. 28, 1926, pp. 454–456 and 458, *dA*. Compare article by Capt. W. H. Sayers, same issue, pp. 446, 448, 450, 452 and 454, illustrated)

ELECTRICAL ENGINEERING

The Eclancher Self-Synchronizing Motor

THE power factor (cos ϕ) of a synchronous motor is equal to unity when the motor is supplied with a direct exciting current just sufficient to provide the magnetizing current which it receives from the line when running asynchronously. If a greater exciting current is supplied the same motor can add to the magnetizing current which the line furnishes to other asynchronous machines and in this way correct the poor cos ϕ produced by these machines. The same principles, as we know, can be applied without the use of a separate source of excitation, no matter whether it is desired to deliver to the motor in such of its elements as are not receiving current from the line an alternating current having a slip frequency, or whether it is desired to supply it with direct current in order to correct the power factor. The method adopted consists in the production of a direct current in a special winding added to the other element of the motor, i.e., the one which is connected to the line. In Fig. 1 it is the rotor that is so used. Because of the presence of the winding C it receives from the three-phase line R a current of a frequency f and through winding A which is of the Gramme type and is connected to a commutator, it delivers a direct current which the brushes B send to the stator S through a star-wound rheostat D which acts as a starting rheostat.

The Eclancher motor shown in Fig. 1 is of the three-phase synchronous type and starts as an asynchronous or induction motor. It consists of a rotor and stator equipped with the following windings: On the rotor two windings are provided, one over the other. The first is a direct-current ring winding A with commutator and brushes B, and the second a star winding C fed with three-phase current from the main line through collector rings and brushes not shown in the drawing.

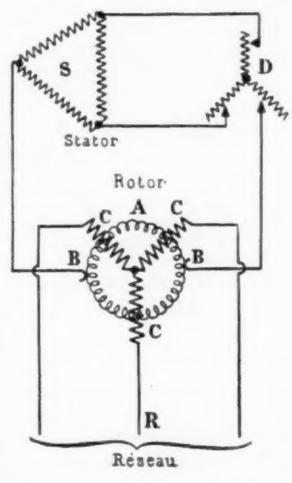

FIG. 1 DIAGRAM OF CONNECTIONS OF THE SELF-SYNCHRONIZING ECLANCHER MOTOR

(*Reseau* = main line.)

The stator carries a delta winding S which, as soon as the motor has been synchronized, receives through starting rheostat resistance D the direct current produced in the exciter winding A of the rotor. The three-phase current coming from the line creates in the windings C and around the rotor A a rotating field, and this field induces electromotive forces of frequencies equal to or different in the stator winding S and in the continuous-current winding A.

Starting. At first and as long as the rotor is stationary, the rotating field produced by the main-line current in the winding C sweeps through stator S with a velocity corresponding to the frequency f of the main line. The secondary electromotive force induced in the windings S across the air gap of the motor has therefore the same frequency f, and the system at that time may be likened either to a static transformer or to an ordinary synchronous motor, if we neglect the presence of the winding A. In likening the system CSD to an ordinary asynchronous motor, however, one must bear in mind that the parts played by the stator and rotor are reversed, the supply current being delivered from the main line to the rotor C instead of to the stator, and the regulation being effected by the action of the star-wound rheostat D on the stator and not on the rotor. On the other hand, however, the rheostat D is not progressively short-circuited as in the case of an ordinary asynchronous motor, but is connected jointly with the winding S to the brushes B pressing on the commutator of the rotor exciter winding A. The part played by this connection is important at synchronization and during the acceleration which precedes the synchronous operation.

Mechanism of Acceleration. Without going into details, it may be stated that from the action of the primary current C on the secondary currents S, a mechanical couple is produced between the stator and the rotor. The mechanism covering the production of this couple is identical in the Eclancher motor with that of an

ordinary synchronous motor equipped with a starting rheostat.

On the other hand, however, the law of variation of the frequency of the secondary currents induced in S from the beginning to the end of the starting period is different, since instead of having an ordinary short-circuiting rheostat cutting in the three-phase windings S, the new motor carries the rheostat D connecting S to the winding A, which, in its turn, is exposed to the inductive action of a rotating field created in the system C by the primary current borrowed from the main line R. As a result of this electromotive forces are induced simultaneously but independently in two quite distinct parts of the complex secondary circuit ASD, one of these parts being stationary and composed of the stator windings S, while the other is movable and is represented by winding A. Between these two local phenomena of induction due to a primary rotating field there may be either the same law of variation during

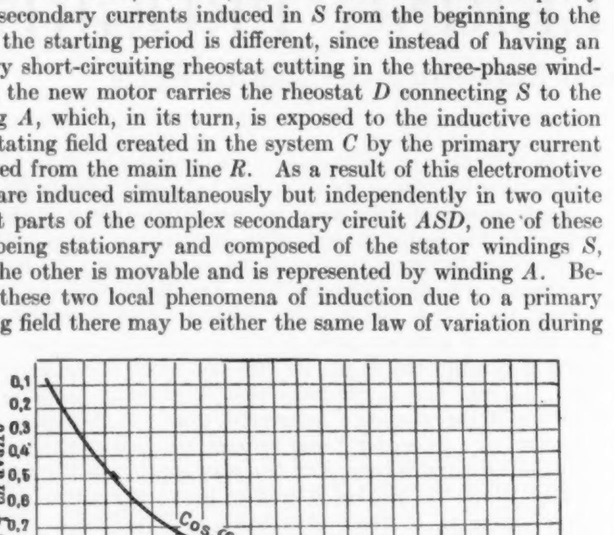

Fig. 2 Characteristic Curves of the Eclancher Motor

the period of starting or else differences which do not prevent having the secondary elements S and A connected across the common starting resistance D.

During the initial state of rest the secondary elements A and S are obviously the seat of electromotive forces whose respective values depend on the number of turns of the circuits, but whose frequencies are equal since both the stator and rotor are at rest and neither experiences any slippage. The winding A adds its electromotive force in a manner asymmetric but nevertheless effective to the electromotive force developed in the stator winding S, and the couple which starts the motor is a function of the secondary current resulting from these two electromotive forces induced in the circuit SAD as well as from the primary current taken from the main line by the system C.

As soon, however, as starting takes place the induction exerted between the system C and the stator S comes in this case under the action of the same law that governs the ordinary induction motor. The frequency of the electromotive forces and of the currents in S is no longer equal to the frequency f of the main line, and becomes what is called the frequency of slip, i.e., it is now equal to the difference between the frequency of the main line and the frequency corresponding to the velocity of rotation of windings C at each phase of starting. In other words, the frequency of the locally induced electromotive force in the part S of the secondary AS varies progressively from f to zero while the motor passes from the state of rest to synchronous running. At the instant of starting, when the velocity of the motor has attained a value corresponding to a frequency value f_m, the electromotive force induced in S differs from synchronism by s_m; in other words, the frequency $f - f_m$ is equal to the frequency of slip.

It is not, however, the electromotive force induced by some two points of the winding A that is collected on the brushes B. The commutator on winding A is practically the same as on direct-current machines, with the difference, however, that instead of acting as a rectifier the brushes B collect from winding A and place in circuit with the stationary elements BS an alternating electromotive force that progressively decreases frequency. At rest this electromotive force has a frequency f. When the velocity of the rotor becomes such as to correspond to a frequency f_m lower than the frequency f of synchronism, the electromotive force collected by the stationary brushes B has the same frequency as if the inductor were stationary and the brushes running at velocity f_m.

When a commutator is explored by movable brushes the latter receive periodic tensions having all degrees of phase displacement, and if movable brushes B when running at a velocity corresponding to a frequency f_m and rubbing against the commutator placed in a rotating field of frequency f, the brushes would collect the frequency $f - f_m$, which is exactly the same as obtains in the stator windings S.

Synchronism. When synchronism has been attained f_m becomes equal to f, and the electromotive force between the brushes B is the same as if these brushes rotated at a velocity f with the field in the presence of a stationary AC system. The brushes therefore collect direct current and the winding A becomes a true exciter winding for the stator S. The motor functions then in the same way as other synchronous motors with or without projecting poles, and equipped with stator windings supplied with direct current from some kind of exciter machine.

The advantage in favor of the Eclancher motor lies in the fact that it provides its own excitation and obtains it by simple means. A further advantage is its ability to raise the power factor from 0.50 to 0.95, and it is not only capable of working with a good power factor itself but of compensating the low power factor of other motors in its proximity. From this point of view the curves of Fig. 2 become of interest. (P. L. in *Le Génie Civil*, vol. 88, no. 14, Apr. 3, 1926, pp. 319–321, 3 figs., *d*)

ENGINEERING MATERIALS

Meehanite Cast Iron

"Meehanite" metal, a new cast ferrous product brought out by the Ross-Meehan Foundries, Chattanooga, Tenn., has an average ultimate tensile strength of 50,000 lb. per sq. in., as compared with 20,000 to 25,000 lb. per sq. in. for ordinary gray iron. Moreover the material preserves its integrity almost up to its high breaking point. The yield point is within 2 per cent of the ultimate strength.

Transverse and torsional strengths, like the tensile strength, are high. Transverse tests made by Enrique Touceda, Albany, N. Y., showed a deflection of 0.03 to 0.05 in. at a load of 2500 lb. and of 0.10 to 0.14 in. at the loads at which the bars broke, which ranged from 5500 to 6600 lb. per sq. in. Torsion tests, also made by him, showed an ultimate twisting moment of 9600 to 10,260 in-lb. for test bars ranging from 1.052 to 1.063 in. in diameter. As to compressive strength, meehanite, it is stated, will stand 125,000 lb. per sq. in.

The Brinell hardness of cast iron varies from 140 for soft machinery castings to 600 for white iron. The average Brinell hardness of meehanite is 258, but it may be readily machined, acting more like steel than cast iron. In cutting the metal in an engine lathe, turnings are formed varying from $^1/_2$ in. to 3 in. long. The turned surface resembles soft steel. Smooth threading of the metal is effected with a lathe tool or die.

Castings made of meehanite, it is explained, may be hardened to as high as 946 Brinell and still retain high tensile strength. Charpy impact tests on 30 specimens of meehanite showed an average of 6.9 ft-lb. of energy absorbed.

The specific gravity of meehanite is 7.49. This compares with 7.41 for malleable iron, 7.20 for gray iron, 7.71 for hard iron, and 7.92 for steel castings.

Meehanite, it is asserted, has great resistance to heat; that there is no change in the strength of the metal up to 800 deg. fahr. Tests at higher temperatures than 800 deg. are now being made.

The physical strength of meehanite is attributed to its dense matrix of uniformly distributed nodules of graphitic carbon, which is well broken up. It is contended that meehanite offeres more resistance to acids than any other ferrous product. This resistance, it is said, is not due to any of the chemical constituents of the metal, but is accounted for wholly by the size of its grains. The

theory is advanced that acids work around the large grains instead of consuming them entirely, causing them to slough out. In the case of meehanite the acid must attack each one of its small grains, and meehanite, it is asserted, has 400 or 500 times as many grains as gray iron. The dense matrix of graphite nodules is also said to be conducive to evenness of wear.

Meehanite is a patented alloy iron. It is not an alloyed metal, however, in the sense that an element is added that is not present in the ordinary gray-iron or malleable-iron charges. The alloy is calcium silicide. Just when it is introduced and in what quantities has not been made public. The process of making meehanite is said to be analogous to that used for making malleable cast iron. White iron is made first, after which the alloy is introduced, transforming the metal into a gray iron.

Meehanite may be made in the cupola, the air furnace, or the electric furnace. Typical chemical analyses of the metal are given in the original article. (*The Iron Age*, vol. 117, no. 21, May 27, 1926, pp. 1559–1560, illustrated, *d*)

FUELS AND FIRING (See also Railroad Engineering: Cinders as Locomotive Fuel)

Motyl and Motalin

The universal motor fuel, benzine, today possesses the following disadvantages: low volatility, low purity, and knocking. In knocking, the first role is played by spontaneous ignition (ignition independently of the spark) and the second by detonation (high-velocity combustion). Walter Ostwald deals with all these questions in "Auto-Technik" and reaches the conclusion that little change is made in this spontaneous ignition by the new "chemical brakes," such as selenium-tellurium compounds, ethyl lead, organic iodine, and nitrogen compounds and even the new agent, "motyl." Motyl, which is being manufactured by the Interessengemeinschaft der Farbenindustrie-Aktiengesellschaft, consists of about equal volumes of benzine and iron carbonyl, $Fe(CO)_5$. It is a yellow, slightly toxic, fluid which is not marketed as such, but is sold only as "motalin" by the Stinnes-Riebeck-Aktiengesellschaft. Motalin is a dapolin colored yellow by the addition of 0.4 volume per cent of motyl. With the use of motalin the detonation knock ceases, but the ignition, carbon, or the other spontaneous-ignition knocks do not. The greater part of the iron oxide arising from the iron carbonyl is doubtless expelled with the exhaust gases as a harmless dust, and, in contrast to lead tetraethyl, the substance is non-toxic. [As regards the use of iron carbonyl as an anti-knock compound, see Mechanical Engineering, vol. 47, no. 12, Dec., 1925, p. 1152.] (*Industrial and Engineering Chemistry*, News Edition, vol. 4, no. 10, May 20, 1926, p. 9, *g*)

Possibilities for the Commercial Utilization of Peat

The peat investigation was authorized by an act of Congress approved Feb. 25, 1919. Workable peat deposits of various grades under widely varying conditions cover a large area of the United States. The manufacturing industries are believed to offer numerous uses for peat, the uses differing according to the localities, but the extended use of peat in most of them depends upon further research, chiefly chemical. Among the products which might be made to a limited extent from peat on a commercial basis under definite conditions are special fuels for certain furnaces and certain metallurgical processes; dense charcoal suitable for the manufacture of charcoal iron or for domestic use; heat-insulating materials, packing materials, etc.

The most extensive series of experiments in the production of peat fuel on this continent were recently concluded by the Canadian Government after the careful expenditure of hundreds of thousands of dollars. As the conditions of production are similar to those in the Northern States, the following figures of the Canadian committee relative to the cost of production are given.

The cost per ton of peat fuel (air-dried macerated peat containing 30 per cent of moisture), based upon 100 working days of 10 hr. each, is $4.48 on board cars at siding. On the basis of a 20-hr. working day, it is estimated that peat fuel can be manufactured and put on the cars for $3.50 per ton, all overhead charges and depreciation allowed. These cost figures probably will not be bettered appreciably by operators in this country under present conditions, and they are the most reliable estimates obtainable of the cost of peat fuel made by this process under conditions similar to those in this country.

Artificial drying of peat—drying by the application of heat from the combustion of fuel—for use as a fuel is not an economic procedure, and should not be considered in this connection. The best method of winning peat, when a dense fuel is desired, consists in excavating the peat from the bog, macerating the wet peat, and spreading the macerated mass upon the ground or on racks in thin layers to dry by exposure to the atmosphere.

Peat fuel must compete with wood and lignite as well as with coal and coke, and it is noteworthy that in many places where conditions are favorable for the production of peat fuel, wood, lignite, or both may be had at a low price. Approximately half of the total peat resources of this country lies in the spruce, tamarack, and cedar swamps of Minnesota, a state where lignite and wood may be purchased at comparatively low prices. Lignite can be mined in North Dakota, where there is a vast supply, at $1.50 per ton or less, and the freight per ton to centers of population in the eastern part of Minnesota is about $2.50 per ton. Lignite of about the same calorific value as air-dried peat can therefore be "laid down" in Minnesota at a net cost of $4 per ton. Any large development of peat-fuel projects in Minnesota must eventually reckon with lignite competition. Furthermore, wood fuel is available at reasonable prices in that state. In this connection it should be remembered that wood of about the same calorific value as peat fuel is sold by the cord, which is equivalent to 2800 to 3800 lb. in weight. This fact is sometimes masked when fuel costs are compared.

The peat in certain peat deposits—notably in Florida—contains a high percentage of nitrogen. Much of this nitrogen (N_2)—approximately 70 per cent—can be converted into ammonia nitrogen upon gasifying in a suitably designed producer-gas generator. To make an enterprise of this nature commercially successful there must be an abundant supply of peat fuel available at a low price, a uniform demand for large quantities of power gas, a supply of cheap acid for neutralizing the ammonia, and a demand at a good price for the ammonium salts made.

This country produces more ammonium salts than it consumes, the sale price is not high, and there is no supply of cheap peat fuel. The principles of this process are well understood and are not new. It is extremely doubtful whether such a by-product can succeed under prevailing conditions anywhere in the United States.

The price of Chile saltpeter, which is 16.5 per cent nitrogen, has considerable bearing upon the price of ammonium salts. Since much of the ammonia produced in this country is exported, the price will probably continue to be influenced by the South American mineral product.

The yield of ammonia from peat of various nitrogen contents is given in the original paper.

The yield and character of the oils from the carbonization of peat vary not only with the different peats but with the method and apparatus used for carbonizing. As much as 20 gal. of oil (tar) per ton can be obtained from good grades of air-dried peat fuel. This tar will contain paraffin oils, wax acids, pitch, etc., in the various proportions. Motor spirits can probably be obtained from this tar equivalent to 2 gal. per ton of dried peat, although the refining loss will be high. The future growth of a peat-carbonizing industry depends chiefly upon finding a good market for the various by-products, and it is believed that the latter will have a greater value in the future than at present. The results of laboratory distillation tests of Minnesota peat are given in the original article.

Peat positively is not a satisfactory fuel for the manufacture of city gas, under prevailing conditions, in gas-making apparatus now in general use.

Peat is now very successfully used as a soil conditioner and is sold under the name of "humus." To a limited extent it is used as a fertilizer filler, but the yearly consumption of peat is not increasing at the same rate as the production of artificial fertilizer. In fact, the production of peat and peat products is at a standstill; there has not been any appreciable increase in a number of years.

Among other things, the present investigation has established that neither in Minnesota, nor in Wisconsin or Michigan (the three states with the largest supply of peat) is peat capable of being used

on more than a local or limited scale. The situation in Florida is discussed in some detail. Neither is there much hope for the peat industry in the direction of wood carbonizing. (W. W. Odell and O. P. Hood, Members A.S.M.E., in *Bureau of Mines Bulletin* No. 253, pp. 1–160, illustr. and map, *g*)

Evolution of Combustion Volumes in Design of Boiler Furnaces for Pulverized Fuel

THE author briefly covers the question of combustion volumes for stoker furnaces, and then proceeds to the discussion of furnace combustion volumes with pulverized fuel. In this connection he presents in an interesting manner the mechanics of combustion of pulverized fuel as depending on the degree of intimate mixture with the air, which in its turn depends on the relative sizes of pulverized-coal particles and oxygen molecules and the degree of intermixture thereof by turbulence and the like. Because of lack of space, only the parts of the paper dealing with the so-called "well-type" furnace can be abstracted. In this furnace (designed by the engineers of the Fuller-Lehigh Co.) an attempt is made to approach the conditions of turbulent flow existing in a tornado where materials of considerable tensile strength have actually been drawn apart, disintegrated and sometimes reduced to powder by intense action of the air. In an experimental furnace jets were placed to throw the flame tangent to a tornado of the fire within the furnace, the flame of the first jet being deflected before it reached the refractory walls by the impingement (with the equal velocity at right angles) of the flame from the second jet, the third jet again changing the direction 90 deg., and the fourth jet completing the tornado within the pot.

It was well known that the external walls of the ordinary tornado had been observed to be rather sharply defined, and distinct from the surrounding air; and thus it was decided to adapt this principle by placing the pulverized-fuel jets in such relation to the walls that there was little, if any, impingement. As was anticipated, therefore, the refractory portion of the walls between the water-cooling tubes showed little damage due to slagging or erosion, and thermocouple readings taken on the inner surface showed temperatures well within the operating range of ordinary No. 1 firebrick.

Early during the experiments the nature of the ignition and combustion taking place in the well proved quite unlike anything experienced engineers had hitherto seen in powdered-coal combustion. The flame itself resembled that of a blow torch, combustion apparently taking place in a limited zone within the well. By regulating the air admission and air pressure it was possible to move the hottest zone into the well itself or to a point just in front of the well. Due to the more efficient transfer of heat by radiant energy caused by higher flame temperatures and lesser *linear* flame velocities, coupled with the intense scouring action of the rapidly whirling gases on the "dead film" surrounding the boiler tubes (known to be the most potent obstacle to efficient heat transfer by convection), the inventor had reason to expect efficiencies higher than had been before demonstrated in pulverized-fuel combustion, as well as a flatter overall performance curve at high ratings.

In February, 1924, the United Electric Light and Power Company, of New York, made a commercial-scale experimental installation of the new furnace at its Sherman Creek Station, where eight other types of pulverized-coal installations were being tried. The efficiencies proved to be from $2^1/_2$ to 6 per cent higher than with the other methods of firing, and the curve of efficiencies at various ratings was much flatter than anything previously demonstrated.

In addition to this, in recent installations there is provided above the well a dispersion chamber in which the hot gases after burning are allowed to expand before reaching the boiler tubes. It is said to have been definitely established that the combined volume of the well and dispersion chamber can be made substantially less than the combustion chamber provided in the ordinary stoker setting. A well-furnace installation has recently been erected by the Duquesne Light Co. at its Brunot Island plant. Another installation of this type now under construction is that of the Buffalo General Electric Co., where four 1200-hp. boilers operating up to 550 per cent of rating will be fired by well furnaces. (H. W. Brooks, Consulting Engr., Fuller-Lehigh Co., Philadelphia, Pa., Mem. A.S.M.E., in *Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 42, no. 1, Feb., 1926, pp. 18–45, 11 figs., *d*)

The Ray Rotary Fuel-Oil Burner Test on a Marine Scotch Boiler

DATA of the tests made in May and June, 1925, of three Ray rotary fuel-oil burners on a single-ended Scotch marine boiler at the Fuel Oil Testing Plant, Navy Yard, Philadelphia.

The burners installed for this test were manufactured by the W. S. Ray Manufacturing Co., San Francisco, Cal., and the size used is known as the 250-hp. size. The burner is said to be unique in its method of atomization. The oil supplied to this atomizer drools upon the interior wall of a rotating cup. The whirling motion of the latter tends to throw drops off radially from the edge of the cup which turns in a clockwise direction (as viewed from the furnace side of the burner). A strong blast of air introduced in a counter-clockwise direction from the vanes of an air nozzle catches the oil which has been partially broken up by centrifugal force, mixes with it, and at the same time propels it into the furnace in the form of a cone of oil fog.

This burner consists of an atomizer and a register, and embodies in each unit a turbo blower which not only rotates an atomizer cup and furnishes "atomization-assisting air," but also helps the register in its function of air admission and control. The register itself is made up of two concentric flanged iron rings, the outer provided with bolt holes for securing it to the boiler front plate, and the inner sliding within the outer. Both rings are provided with twelve square air-admission areas. By adjustment of the inner ring the size of these air-admission areas may be regulated. Passage of air to the furnace is from the inner face of the inner ring of register through the twelve air-admission areas. The center of the register is closed by a circular hinged iron door lined with plastic refractory. In the center of the door a hollow truncated cone known as the nozzle protector provides the space for the entrance of the atomizer and nozzle.

The turbo-blower atomizer ensemble is hinged to the same lugs as is the plastic-lined register door. The turbines are of the hollow-shaft double-stage impulse type with the single $^7/_{64}$-in. throat nozzle. This drives a centrifugal fan which has the function of supplying air to assist atomization as well as for combustion. The air is sucked into the main air duct by the rotation of this fan and is cast outward along the guide blades between the aluminum-alloy disks of the fan into the interior of the housing, whence it passes through vanes to the forward orifice of the fan housing and to the stationary air nozzle, and thence discharges the air into the oil spray with the counterclockwise rotation.

The atomizer cup which rotates within the hollow center of the air nozzle is a brass cylinder, with the interior surface sloping outward at a very slight angle toward the delivery end which is slightly rounded. This atomizer cup is threaded on to the hollow shaft of the turbine and, like the centrifugal fan, revolves with it. Fuel oil reaches the interior of the atomizing cup via a $^3/_8$-in. stationary tube, passing through the hollow shaft of the turbine. A $^3/_8$-in. nozzle is threaded to the tube end, and from this the combustible drools up the interior surface of the atomizer cup.

The functioning of the atomizer cup and the delivery of air from the vanes of the stationary nozzle has already been explained, but it is to be noted also that the strong blast of air making its exit from the air nozzle sets up a strong suction. This aspirator action induces a pronounced flow of air from the fire room through the space between the furnace side of the fan housing and the fire-room face of the plastic-refractory-lined door, and thence into the furnace around the air-nozzle exterior. Thus the air from the nozzle vanes is supplemented by additional air for combustion, not only through the air-admission areas of the register, but by this induced flow between the air nozzle and the air-nozzle protector.

The oil and steam piping to the burner is so designed that it also forms the hinge pins of the plastic-refractory-lined door and the turbo-blower-atomizer door. This obviates the necessity of disconnecting any couplings when a burner is to be swung outward (door-fashion) from the furnace front plate.

The following two are said to be the outstanding results established as to the combined efficiency of furnace and burners:

1 That with these burners on this boiler, the percentage of com-

bined efficiency of furnace and burners increased as the combustion rate was raised. As curves were still ascending at highest rate plotted, they showed that the combustion rate at which the burners themselves would attain their maximum efficiency was not reached on these runs.

2 That the curve drawn through the spots of runs made with the less viscous oil at viscosity in the vicinity of 560 sec. Saybolt Universal was more than 2 per cent above the similar curve drawn through spots of runs made with the more viscous oils at viscosities in the region of 7000 sec. Saybolt Universal. The spots for runs 12 and 13, however, fell more than 4.5 per cent above the curve through spots plotted for runs made with the less viscous oil, although they were made with the more viscous oil. These combined efficiencies of furnace and burners of over 98 per cent were due to the extreme lowness of the summation of losses chargeable to furnace and burners, which were on runs 12 and 13 greatly diminished through reduction of losses due to unburned hydrocarbons.

Atomization with this centrifugal air atomizer is not a function of the oil pressure, but of the turbine speed, and of the velocity of the air flow through the air nozzle.

Oil of viscosity in excess of 11,000 sec. Saybolt Universal is satisfactorily atomized. This figure represents the maximum viscosity used during test—not the greatest of which this burner is capable. The more viscous the oil, the greater the advantage of operating at high turbine speeds.

Burners are slightly more efficient when burning relatively non-viscous than with more viscous oil.

Oil containing 7.8 per cent water by volume in suspension can be burned with little difficulty.

The foremost advantages of this type of atomization are: (1) The capability of satisfactorily atomizing oil of very high viscosity, high water content, and also oil sludge or oils containing residual or sedimentary material. (2) Knowledge of the viscosity-temperature characteristics of the oil utilized for firing—indispensable for the most efficient results in operation with mechanical pressure-type atomizers—is unnecessary. (3) Shifting of atomizer parts—tips and plugs—with changing rates is unnecessary; great flexibility with varying load conditions is thus attained. (4) High-pressure pumps and piping are unnecessary.

The rate of firing per burner at which greatest burner efficiency would be obtained is greater than 525 lb. per burner per hour; hence the burners were oversize for the rates run.

The most efficient method of operation is to run the turbines at high speed with the air registers wide open, using the stack damper for control of the draft at low rates; at maximum rates the damper should be wide open. The minimum speed of the turbine for good atomization with relatively non-viscous oils (500 sec. Saybolt Universal at temperature of firing) is probably in the vicinity of 1800–2000 r.p.m.; approximately 2300 r.p.m. would be necessary for the more viscous oils (7000 sec. Saybolt Universal at temperature of firing). When atomizing at rates above 300 lb. per burner per hour, maximum turbine speeds should be used. The general procedure for damper and turbine control above 300 lb. per burner per hour is therefore that the damper should be opened to produce the required air flow through the register, in excess of that being delivered of induced by turbo-blower. (R. C. Brierly, Test Engr., Fuel Oil Testing Plant, Navy Yard, Philadelphia, Pa. in *Journal of the American Society of Naval Engineers*, vol. 38, no. 2, May, 1926, pp. 271–288, and several sheets of data and illustrations, *e*)

HEATING AND VENTILATION

Humid Air as a Heat Medium

There is an advantage in heating with a low-temperature medium not only because of the great economy but because of the greater ease of regulating the supply of heat to meet the requirements of varying temperature conditions. The author analyzes hot-water vacuum systems and the so-called modulation or vapor systems, and shows the advantages and disadvantages of all of them. With present methods of control and operation and with present volumes of radiator admission valves, control of heat output to a radiator is difficult unless the boiler pressure is very accurately held to a fixed operating point. Furthermore, comfortable heating of rooms with a small temperature differential between floor and ceiling and a comfortable knee-high temperature is no less important than economy of operation. All of this can be attained only with the definite control of radiator temperatures and a wide range of possible temperatures attainable in the radiator.

The author proposes a solution involving the use of saturated or humid air as a medium for heating with the ordinary form of radiating surface. The use of such a system requires, first, proper provision to replenish the supply of vapor as it condenses, and, second, means to mix the air and vapor. The device as actually used is shown in Fig. 3 and consists of means for mechanically mixing air and steam in the radiator so as to form a humid mixture in which the heating medium is the steam or vapor carried by the air. Mechanically the device is of the standard design and dimensions of the conventional radiator admission valve, operating in exactly the same manner and differing only in the metering effect obtained.

The original article shows and describes in detail the steam admission valve (top left-hand corner of Fig. 3) arranged to deliver steam to the radiator and control the area of opening of the metering slot.

In the radiator section, Fig. 3, equipped with this valve, there is shown diagrammatically the action of the humid mixture within the circuit, the valve being shown four-eighths open. Full opening is accomplished on a seven-eighths turn of the handle. The first four eighths are utilized for metering through the metering slots and the last three eighths for full opening when input demand calls for heating the radiator to the full temperature of the steam. It is observed that the jet of humid air leaving the venturi tube does not expand until it has passed through the first nipple of the radiator, and consequently that the first loop is utilized for the induced flow of the humid mixture from the lower portion of the radiator upward and into the mixing chamber. There is a downward travel of the humid mixture in each succeeding loop and a reverse travel across the bottom connection of the radiator, accomplishing a through circulation and a corresponding uniformity of temperature. Even when full open, part of the steam, diverted through the jet, serves to circulate the steam throughout the circuit, improving the heating effect, as it is well known that the passage of a heating medium over a radiating surface is more efficient than the same medium lying inert against that surface.

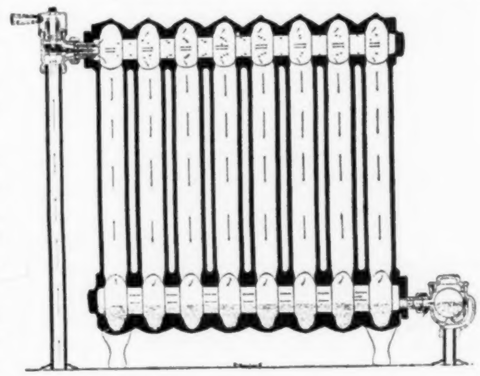

Fig. 3 Standard Hot-Water-Type Radiator Equipped to Use Humid Air as a Heating Medium

It is to be noted in the section, Fig. 3, that the valve is delivering to the radiator, at high velocity, make-up steam in the form of a jet, the action of which mechanically generates the humid mixture of required temperature within the radiator, and mechanically circulates the humid mixture within the radiator, providing in this manner a method of heating by steam, by which, with steam at any temperature and pressure, radiators or similar vessels may be uniformly heated over their entire surface to any specified temperature—from that of the original air content of the radiator to the temperature of the steam corresponding to its pressure—and in this manner accomplishing by a definite control of the steam consumption the first principle, economy, and by a definite control of the steam input and the circulation, the uniformity of temperature, below steam temperatures which result in the accomplishment of the more comfortable heating of the room.

It is claimed that actual installations where other systems have been compared to the new system by a metering of all condensation show that the average saving in fuel exceeds 25 per cent. (Foskett

Brown, Nashville, Tenn., in *Journal of the American Society of Heating and Ventilating Engineers,* vol. 32, no. 5, May, 1926, pp. 331–338, 5 figs., *d*)

INTERNAL-COMBUSTION ENGINEERING

The L G Piston for Automobiles

While light-metal pistons obviously present certain advantages, the problem of their introduction has proved to be a much more difficult one than that of cast-iron pistons, largely because of their greater heat expansion.

It is claimed that the L G piston, made by the Knorrbremse Company, of Berlin, has solved this problem in the following manner. This piston (Fig. 4) consists of a cast-iron barrel on top of which is set a light-metal piston head resting on an edge packing and held firmly to the piston body by the pressure of a spring washer. The pressure of this spring washer is four times greater than the centrifugal force of the piston head at its maximum. The piston head, however, is not rigidly attached and is subject only to pressure in a downward direction, the spring washer taking care of the expansions due to heat. The piston barrel (which is of cast iron) has the necessary means for attaching the connecting rod. It is claimed that the heat transfer from the light-metal piston head to the cast-iron piston barrel and from the latter to the cylinder wall takes place in an unusually favorable manner, and tests have said to have indicated that from a thermodynamic point of view this piston is equal to an all-light-metal piston, while in other respects it retains the advantages of a cast-iron piston. (Hans Wunderlich in *Der Motorwagen,* vol. 29, no. 10, Apr. 10, 1926, pp. 211–213, 7 figs., *d*)

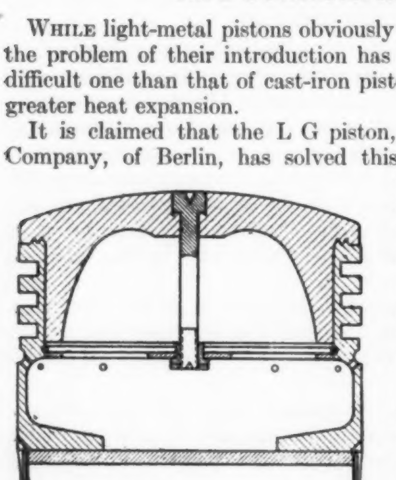

Fig. 4 The L G Two-Metal Automobile Engine Piston

M.A.N. Double-Acting Two-Cycle Engine

Description of a new type developed by the Maschinenfabrik-Augsburg-Nürnberg (Compare description of the experimental 12,000-hp. engine built by the same concern in Mechanical Engineering, vol. 47, no. 1, Jan., 1925, p. 46). The chief departure from the earlier types is in the abandonment of the scavenge valves in favor of scavenge ports. The scavenge air enters through a duct serving the middle of the cylinder and passes through independent ports in the cylinder walls to the upper and lower cylinder ends, being directed in such a manner that it sweeps across the piston face to the far side of the cylinder. Guided by the cylinder wall it returns from the combustion space, pushing out the exhaust gases through exhaust ports adjacent to the scavenge ports.

The cylinder head is designed with the idea of having a separate port for taking care of the heat stresses, and an outer cover for resisting the mechanical stresses. The inner cover is generally referred to as a "heat shield," and is just a shallow water-cooled drum. The outer cover is entirely uncooled, and serves not only for holding the fuel valve but is made deep enough to act as a member of the rigid girder formed at the top of the engine by bolting the heads together. (Compare Fig. 5.)

The fuel valve is in the center of the head and is the only valve in the head proper. The starting valve and the relief valve are fitted horizontally in the upper part of the cylinder, and recesses for them are formed in the heat shield. In the lower cover the two-piece construction is also practiced, but the outer cover is not made deep because rigidity at this part of the engine is furnished by the entablature. Through the two parts of the lower cover of course passes the piston rod, for which a water-cooled stuffing box is provided in the outer cover. This stuffing box prevents a central fuel valve being used, and in place of it are found four small horizontal fuel valves, slightly offset from the cylinder diameter in order to give a good distribution of fuel without the sprays impinging upon the piston rod. A starting and a relief valve are fitted in the lower cylinder end in the same manner as in the upper.

The starting valves are so arranged that they stay shut whenever the pressure in the cylinder exceeds the pressure of the starting-air supply. With this precaution it was deemed permissible to allow the fuel pumps to operate during the starting period. Each cylinder has two fuel pumps fitted directly above the camshaft and illustrated in detail in the original article. In these pumps the fuel-pump stroke is constant, but the amount of oil supplied to the fuel valve is determined by the moment at which the bypass valve to the suction closes on the delivery stroke. The delivery of fuel from the pump to the injection valve is timed to occur immediately prior to the period of injection into the combustion chamber. This is a safeguard against fuel entering into the cylinder at wrong periods during the maneuvering, as might otherwise happen with the fuel pumps always working, as they are on this engine, even during the periods when starting air is being admitted to the cylinders.

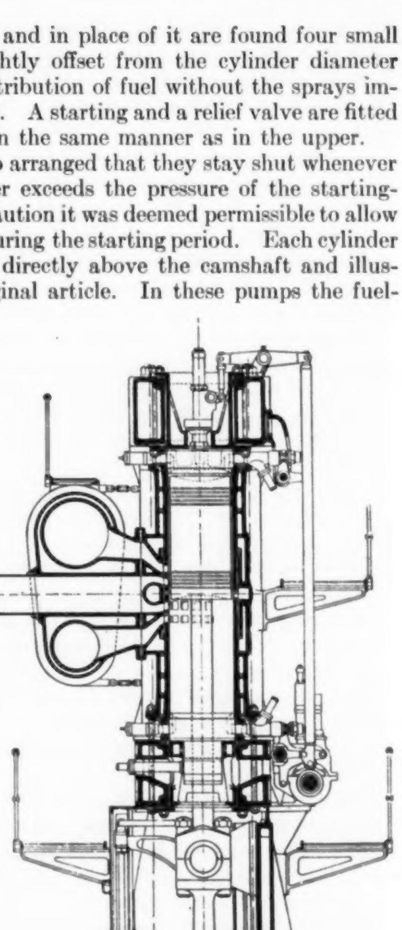

Fig. 5 Section Through M.A.N. Double-Acting Two-Cycle Engine

A six-cylinder engine of this type was built for the motorship *Ramses* of the German Austral and Kosmos Lines. Its six cylinders of 27.56 in. diameter and 47.24 in. stroke developed 4400 b.hp. at 84 r.p.m. The engine weighs 485 tons with flywheel but without gear, air-injection system, scavenge manifold, and exhaust manifold. Several other engines of the same type were built for other concerns, among these being two built in this country for the U. S. Shipping Board, one by the New London Ship and Engine Company and the other by the Hooven-Owens-Rentschler Company. (*Motorship,* vol. 11, no. 5, May, 1926, pp. 367–370, illustrated, *d*)

MACHINE SHOP

The Division of Labor in Tool Manufacturing

The Western Electric Company makes all the equipment used by the Bell Telephone System, in addition to which it handles a large amount of other work. In this connection it has the problem of making some 110,000 different parts which are assembled into 13,000 separate and distinct pieces of apparatus made in a great variety of shapes and of many materials. At the Hawthorne Works alone there is today approximately $12,000,000 invested in tools and $1,000,000 in toolroom equipment. During 1925 there were manufactured at this works 4400 major tools at a cost of about $850,000 and $485,000 worth of small tools such as special milling cutters, reamers, taps, button dies, wrenches, etc. It is therefore a very large organization, and the elimination of waste by a proper division of labor becomes of really great importance.

The author begins by describing the methods of making a tool in 1895, when the toolmaker practically handled the whole job. Today it is the planning organization that determines the kind and type of tool to be made, based upon the annual demand for the part. The higher the requirements for the given part, the greater becomes the possible saving in the cost of production and the more reason there is to spend money on the tool. If, for example, brass washers $^5/_8$ in. in diameter with a $^1/_4$-in. hole are required, a hand screw machine would be used to fill an order for 5000 pieces annually. Should the demand for the washer be 30,000 annually, the part would be produced from sheet stock on a punch press using a one-at-a-time tool and punch. A demand for 3,000,000 parts annually would warrant the expense of building a three-at-a-time or a seven-at-a-time perforating and blanking punch and die, respectively. The tool cost of producing these parts in accordance with the four methods would increase from \$10 to \$600, whereas the production cost of 1000 parts would decrease from \$10 to \$1.52. This is the business of the planning engineer.

Next comes tool designing. This division is divided into four departments—the punch and die department, the jig and fixture department, the gage department, and the screw-machine tool department. The designers in each of these groups work almost entirely upon one particular type of tool, which makes for a more efficient design and lower design cost.

With the large requirements at Hawthorne, standardizing of tool parts was an obvious step, and as a consequence the Tool Design Division has compiled a very complete set of standards. These standards cover such items as punch and die holders, sub-press frames, die blocks, liner pins and bushings, dowel pins, automatic stops, springs, and screws. Considerable progress has been accomplished in standardizing the tool designs, thus eliminating the necessity of making a complete design for each tool, and standard designs have been made showing the complete standard tool. In the case of a standard punch and die, all the drawing that is required is a layout showing the part to be made, which together with the standard parts previously mentioned, is all the information required by the toolroom to complete the tool. The standard parts to be used are shown on the tool drawing or tool layout, designated by the number under which they are stocked.

This standardization makes it possible to produce these parts on a quantity basis and to stock them ready for use, and in addition provides an excellent line of work on which to train the toolmaker apprentice as well as the specialist. These standards, then, have given the plant quantity production of parts, insure adherence to practices which experience has proved to be the best, and have cut the cost of tool drawings to a minimum.

From the Tool Design Division the tool order, together with drawings, goes to the tool-ordering organization, which forwards the order with complete description of tool, final estimated cost, and description of the part to be made, to the shop.

In the shop the specialization of work is carried to a high degree. The toolroom is divided into the following main groups: The milling-machine section, the lathe section, the grinding section, and the bench-work section. These main groups are still further subdivided as follows: In the lathe section there are specialists on threading plug gages and master taps, and still others who turn only circular forming tools. The bench-work section is subdivided into punch and die work, gage work and general tool work, which includes drill jigs, assembling and milling fixtures, screw-machine tools, etc., and in the die gang there are compound-die makers, tandem-die makers and forming-die makers, who perform only the bench work necessary in the building of these dies.

The author next describes the inspection required and indicates the degree of accuracy called for on some of the tool work. Thus, in one of the instances described, a clearance of 0.0005 in. is allowed between the punch and die opening, whereas the perforator openings are only 0.0002 in. larger than the perforators, and the clearance for certain reasons can be neither smaller nor greater.

The author next proceeds to show how the cost of work has changed from the old method to the new. A job which under the old method would take 53 hr. and cost \$53, takes under the new method $42^1/_2$ hr. and costs \$34.70. This is due entirely to the fact that an equal or an even better job can be obtained with cheaper-grade operators who specialize in one class of work. Under the old method only 20 hr. out of 53 consumed by the job required the services of a high-grade toolmaker at the top rate, and during the other 33 hr. he was doing work which could have been done equally as well by a machine specialist at a lower rate of pay.

The author mentions in conclusion that he looks confidently for continued improvement in the economy of tool manufacture along the lines of still further specialization. The demands of the telephone industry and others for a very increasing quality and quantity of product make it imperative. Were the Hawthorne Works to revert to the old practices they would need today approximately 800 skilled toolmakers, whereas they have now only some 180 who come into this class. It is doubtful if they could get these 800 if other industries would make similar demands, and this brings in another phase more or less immeasurable but of vast social importance. By this division of labor, lines of work have been opened up for the more or less unskilled man and enabled him to earn wages greater than were hitherto possible.

Again, with such a variety of work, men with initiative and ability have splendid opportunities for advancement. Success at one class of work means promotion to the higher grades, so that at the present time a large number of highly skilled men now in the plant have come up from the work of specialists on the various machines. This upward movement is constant and steady. The shop hand with design ability, or of a keen analytical turn of mind, who develops these gifts of study, finds a ready opening in the planning and tool-design work, fields of endeavor practically unknown thirty years ago. In fact, many of the Hawthorne executives today have traveled this road. (G. A. Pennock, Tech. Supt., Hawthorne Works, Western Electric Co., Chicago, in *Journal of Western Society of Engineers*, vol. 31, no. 3, Mar., 1926, pp. 97–102, *dg*)

MOTOR-CAR ENGINEERING (See Internal-Combustion Engineering: The L G Piston for Automobiles)

POWER-PLANT ENGINEERING

The Richmond Station of the Philadelphia Electric Co.

This station, destined to be the company's largest plant, is located on the bank of the Delaware River a few miles northeast of Philadelphia proper, and is planned for an ultimate capacity of 600,000 kw. At present the units installed are rated at 50,000 kw. each, but loads in excess of rating have already been carried, and it is feasible by slight construction changes to increase the rating materially. Ample boiler capacity is available for these increased ratings.

The turbine hall is a magnificent room with a great arched ceiling and glistening white walls. It just lacks one foot of being 350 ft. long, with the dome 150 ft. above the turbine room so that an eight- to ten-story building could be built beneath the ceiling.

The main turbine units are mounted on island-type foundations with the shafts at right angles to the lengthwise dimensions of the turbine hall. The boiler room is approximately square, with 24 boilers arranged in four rows of six. The original article presents the following percentage distribution of costs. No allowance in

	Per cent of total cost
Land	3.19
Piers and bulkheads	1.26
Dredging	1.16
Yard (fill, track, paving, planting)	1.33
Substructure	5.94
Tunnels and screening basin	9.65
Superstructure	26.13
Coal tower and conveyor structures	3.76
Coal-handling equipment	1.19
Boilers and stokers	10.86
Draft equipment, stacks, flues	1.39
Feedwater equipment	1.03
Boiler-plant piping	5.44
Miscellaneous boiler-plant equipment	3.17
Turbo-generators and foundations	8.75
Condensers, auxiliaries, and water system	3.04
Electrical equipment	10.99
Miscellaneous plant equipment	1.72
Total	100.00

these figures has been made for the fact that parts of the present construction are applicable to the first section and other parts of the station included in the ultimate plan.

All furnaces are equipped with Bailey water-cooled side and bridge walls. The furnaces have a volume of 7800 cu. ft., which is equivalent to 0.935 cu. ft. per installed kilowatt, or 0.496 cu. ft. per sq. ft. of boiler surface. Taylor underfeed stokers are used throughout. These have 15 retorts with 25 tuyeres and a total active combustion surface of 362 sq. ft. In addition to the usual records, for each boiler a graphic record is made of the temperatures of the flue gas leaving the boiler and leaving the economizer, and of the temperatures of the air entering and leaving the preheater.

Centralized control is provided only for the forced-draft dampers. Each row of six boilers is under common control, with the control board at the head of the firing aisle. Since the induced-draft-damper position of each boiler is automatically controlled to maintain balanced draft, the central control of forced-draft-damper position indirectly controls the induced-draft dampers also. Two 6-point indicators of forced draft-damper position and windbox pressure are installed on the central control boards. Stoker speeds and the speed of the forced- and induced-draft fans are controlled only individually from each boiler control board. At the center of the firing aisle are placed back to back two master pressure gages and two load indicators with two-foot dials. (*Power Plant Engineering*, vol. 30, no. 10, May 15, 1926, pp. 564–573, 11 figs., *d*)

Experiences with Modern Stations

Extracts from a report presented to the National Electric Light Association. According to this report, no one factor gives a true picture of the economy and satisfactoriness of generating stations. Furthermore, until there is a great reduction in the tendency to misuse facts, there is not much hope of telling the complete story. As regards firing methods, very satisfactory reports have been obtained from operators on both pulverized-fuel and stoker firing under adverse conditions without their concealing the fact that some problems remain to be worked out. Despite the highly satisfactory experience with pulverized-fuel combustion, operating engineers contend that stokers are not a dead issue by any means. The choice of firing methods has been further complicated of late by the introduction in the powdered-fuel field of the unit or direct-firing system. Opinion on this development has not crystallized so far.

Experiences with Powdered Fuel

Regarding powdered-fuel combustion, the most favorable comments center chiefly around the speed with which boilers can be brought up to or above rating, the efficiencies and percentages of nominal rating obtainable, unit labor and energy requirements for coal preparation, and experiences with driers, mills, coal transport, powdered-fuel bins, coal feeders, furnaces, and boilers.

Bringing Up Boilers. During normal operation it is customary for station A to bring up powdered-fuel boilers from no load, but full steam pressure, to 230 per cent of rating in five minutes. Loads can be increased from 200 to 300 per cent in regular practice in less than one minute. At station D, starting with a hot boiler, 2 min. 35 sec. was required to attain 50 per cent nominal rating after lighting the burners, 3 min. 7 sec. for 100 per cent of rating, and 5 min. 30 sec. for 305 per cent of rating. This speed is considered the maximum safe rate of applying heat to the furnaces.

The limit to bring a cold boiler up to load is the amount of heat the brickwork can safely absorb; the incomplete combustion and consequent smoke caused by the cold brickwork is another limitation. The forcing limit is also determined by the character of water and the rate of coal feed that will cause excessive wear of the transport system. Normally station A brings up a cold boiler to full load in two hours, whereas station F takes about four hours. Although it would not follow the practice regularly, station C has brought up a boiler from the cold condition to the steaming point (but producing no pressure) in 5 min. About ten minutes is required from this point to bring the boiler up to normal load.

As regards efficiencies and ratings, one of the stations reports that it has been found possible to carry 300 per cent of nominal boiler rating with nine vertical burners per boiler; with six horizontal feeders in use as well, 450 per cent of rating can be carried. Another station carried a rating of 400 per cent for six weeks steadily, 14 hr. per day. However, the company believes that 350 per cent is the maximum that can be carried safely continuously. It is impossible to operate the station efficiently below 180 per cent of rating because of the impossibility of cooling the walls without introducing too much excess air.

There is a good deal of difference of opinion regarding the conditions under which driers are necessary. One station does not dry the coal at all, because large daily shipments of coal provide dry fuel to supply the pulverized-fuel furnaces, any wet coal received being burned on stokers or stored. Another station declares that driers are needed at certain times of the year. Finally, a third station to facilitate coal transport and avoid clogging of the valves and feeders prefers to dry the coal so that it will contain not more than two per cent of the surface moisture.

Mills. The comment is quite general that if larger mills will give as good experience as the 6-ton mills now used, they should be installed in the future, because not more than one man is required for every seven or eight mills regardless of the size. Six $8^1/_2$-ton gear-driven screen-type pulverizer mills and one 20-ton mill are used by station C. Both stations A and D, which use 6-ton pulverizer mills, report that they stand up very well, the exhauster fans requiring the major maintenance. The blades of the fans used by station A have to be replaced after about 1100 to 1400 mill-hours (at 6.2 to 6.5 tons per hr.) or after about 8000 to 10,000 tons. Station D says that the blades can be replaced readily in an hour. Various materials have been tried to make the blades stand up longer, but station A is still relying on boiler-steel plate for replacing the blades in the spiders.

Experience with roll-type mills at station D has been very satisfactory, they being relatively quiet (a measure of vibration and consequent wear) and the maintenance not being high. In station A the mill rolls last about 18 months at a pulverizer rate of 6.2 to 6.5 tons per hr. before the company has to consider replacing them; the mill cases last about 50,000 tons. The plow tips that lift the coal in the process of pulverizing constitute a smaller item of maintenance. The fineness to which the coal is pulverized has been reduced from 60 per cent through a 200-mesh sieve to 43 per cent, but there is no question at present whether 43 per cent is too coarse. Station F reports that considerable dust still escapes from the cyclone vents and its deposit is rather objectionable.

Coal Transport. Very little trouble has been experienced with coal-transport systems other than that due to wear of the exhauster fans and the sheet-steel piping, provided the surface moisture of the coal is held down, sufficient air is injected to float the coal, eddies are avoided, and valves are properly operated.

Air around the conveyors and cyclones may be kept at about 70 deg. fahr. contends one station, although this experience must not apply to other than the screw-feed type of coal transport. At another station the air is cooled after leaving the compressor, the moisture separated, and the temperature raised before the delivery to the transport system. This station has slightly increased the ratio of air to the amount of coal feed above that originally planned, but attempts are being made to reduce it. If the air is shut off the coal-transport lines tend to clog, the moisture content of the coal being the chief influencing factor, however. Sticking of the valves in the transport and feed lines is avoided chiefly by operating them at least three times a day.

Feeders. The report describes various ideas existing regarding feeder drive and burner arrangements. For example, one station has 16 coal feeders per furnace. From tests that have been made in considering the quality of coal burned at this plant it appears that 1.7 lb. of coal can be burned safely per cubic foot of furnace volume per hour, giving a boiler rating of 400 per cent. (This station reported, however, that it believes 350 per cent of rating to be the maximum that can be carried safely continuously.) Duplex feeders are used as a compromise between group and individual drive, no interconnection being provided between adjacent groups. The flexibility of control afforded by this arrangement is considered necessary because the density of coal in the different feeders varies. At this plant (and also at another one) capscrews are inserted around the periphery of the feeder spirals 100 deg. apart to break down any arches of coal that form.

Triplex feeders, of which there are five motor-driven sets to each furnace, are employed by another station for furnaces having a volume of 12,931 cu. ft. each. A station which installed one burner at the bottom of the furnace and two above, found that the lower burners did not permit the fuel from the upper burners to sweep down through the furnace sufficiently for complete combustion. Consequently the bottom burner is now omitted. These burners are tilted 20 deg. from the horizontal. It should be pointed out, however, that this particular station employs semi-turbulent combustion in its furnaces. It was found that too great turbulence resulted in losses, but of an entirely different nature from those with entire lack of turbulence as with the straight-shot burner.

Furnaces and Boilers. It appears that furnace-wall deterioration can be kept within desirable limits by avoiding flame impingement, high CO_2, and excessive rates of heat application, and by constructing the refractory walls to allow for expansion with water screens or using water-cooled metal-faced furnaces. Slagging is minimized by maintaining the correct furnace temperature with relation to the ash-fusion temperature, and is protected against by water screens and wall protection where the nature of the coal demands it. The rate at which coal can be fired is not limited by the mechanical apparatus, but by the rate at which heat can be absorbed by the furnace walls and the temperature at which excessive slagging occurs. Practically no precautions are necessary to prevent burning of boiler tubes other than what is good practice for operating any boilers. Owing to the high cost of large-volume combustion chambers, considerable attention is being given to means of creating more turbulent combustion and thus assuring complete combustion with smaller furnace volume. Apparently there is a limit beyond which turbulence of combustion can be carried with beneficial effect on furnace performance.

Some erosion of the furnace walls in station A has occurred, but there is a question whether it is due to flame impingement or zones of high CO_2. The furnaces, which have tube screens across the hearth, are operated normally to give 230 to 250 per cent of nominal boiler rating. The average temperature of the furnace is 2400 deg. and the fusing temperature of the ash is 2100 to 2600 deg. fahr. The chief brick trouble is due to spalling and lever action. Experiments are being made with different kinds of furnace-wall construction to allow for the expansion necessary. No troubles from clinker formation and wall deterioration have been experienced by station D, as it operates chiefly around 200 per cent of rating. The average rating of the pulverized-fuel equipment in pounds of fuel per hour is 74,800.

The water-screen boiler tubes protecting the furnace hearth of station A cause the ash to deposit in granular form like sand that can be easily sluiced away hydraulically, although some clinkers pass through which clog the sluice and must be removed. At station F the firemen are very careful not to let the flames pass through the water screen, and to maintain as even combustion as possible.

For protection of refractory walls, water screens in addition to wall ventilation has possibilities, declares station A. However, the advisability of using cast-iron walls is chiefly an economic problem and a question of how often they will have to be replaced.

No trouble has been experienced with burning of boiler tubes at station A, but the station had some trouble with the water-screen boilers due to scaling at high ratings (1100 to 1200 per cent) caused by poor water or poor distribution thereof. This trouble was corrected. Considerable formation of clinkers on the boiler tubes of station F has been experienced, which gradually fills up the spaces between the tubes. To remove them an air lance is used quite effectively once each day on the front row of tubes on all active boilers. Some blistering was experienced on the upper half of the water-screen tubes prior to their being covered with a tile similar to the C-tile used for baffling Heine boilers. At station A slight slagging has occurred on the boiler tubes exposed to the fire and at the entrance of the first pass, and steam and air lances have been used to remove it, but all of the tubes cannot be reached from the handholes while the boilers are in service.

No trouble has been experienced with clinker formation or brickwork trouble at station C, but this station has not been in operation long. In addition to the rectangular-cross-section powdered-fuel furnaces, there is one circular furnace, designed for semi-turbulent combustion, which is 18 ft. in diameter and the same height as the other furnaces. The circular furnace, with tangential coal feeds, keeps the flames from impinging on the furnace walls, and the secondary inlets between coal feeds permit better mixing of the air and coal. If all the furnaces in the plant were of the circular construction, the company believes that the construction costs would be lower than for the customary rectangular furnace using less turbulent combustion.

Probably the most extensive experiences with semi-turbulent combustion have been had by the company operating station K, where unit pulverizers are applied. About 0.575 cu. ft. of furnace volume was employed per sq. ft. of steam-making surface. To effect complete combustion a new type of burner was employed which supplies with the coal 50 to 80 per cent of the air required for combustion, the remainder being admitted through deflection vanes around the fuel nozzles in the furnace.

In view of the unsatisfactory experience which this company had with air-cooled walls at station E, water-cooled walls were used at station K, to permit sustained high rates of combustion without damage. Precast refractory-faced cast-iron blocks replaced the usual furnace brickwork, excepting on the front and rear walls. A refractory composed of alundum and fireclay was found most desirable. Bare cast-iron blocks were used on the lower section of the furnace to prevent slag formation during operations.

With this construction it is possible to operate at rates in excess of 300 per cent continuously without the formation of molten slag or injury to the furnace walls. With water-cooled walls there is a reduction of about 6 per cent in the temperature of the steam leaving the boiler, so the convection-type superheater was supplemented by a radiant superheater on the rear wall of the furnace.

Stoker Experiences

At one of the stations tube slagging, while no more than would be expected with the grade of coal and ash used, is reported to be serious enough to cause reduction of output if allowed to collect until the boilers are shut down. By inserting a hand lance under 50 lb. water pressure and with a $^1/_4$- or $^1/_8$-in. nozzle through the handholes just below the front of the lowest boiler tubes (Babcock & Wilcox), it is possible to remove the slag on the tubes while they are in service. No tube trouble was experienced as a result of this practice.

Main-Unit Bleeding

The effect of bleeding under operating conditions has been exhaustively studied by one station which bleeds only one stage with hand control.

Curves are given in the original article showing the effect of different unit loads and amounts of steam bled on water rates, bleeder pressure, feedwater temperature, etc.

In another station the twelfth and sixteenth stages of the turbines are bled, hand control being employed. To secure the greatest station economy all the extraction possible is taken from the sixteenth stage, and the deficit made up from the twelfth stage. With full unit loads there is more bleeding capacity than is necessary to maintain the desired feedwater temperature. The company has not considered it advisable to have more than three bleeders (only two are installed) because of the added investment, attention, complications of the turbine barrel, etc.

At still another station steam is bled from the eighteenth, twenty-second, and twenty-fourth stages. No attention is necessary with load changes unless the load per unit drops considerably, in which case it might be necessary to shut off the last bleeder. When operating at full load without extraction and returning the leakage from the high-pressure packing to the twenty-second-stage shell, the water rate of these turbines is expected to be 7.67 lb. per kw-hr. according to the guarantee. Other methods of bleeding are described, including the four-stage bleeding.

Steam Reheating and Air Preheating

Reheating of steam between the high- and low-pressure elements of turbines has been used so far only in stations operating at pressures in the vicinity of 600 and higher to assure dry steam

through the low-pressure stages and thus reduce blade erosion. Some designers and users are now considering the omission of reheating in 600-lb. plants for that part of the equipment that does not operate at a high-capacity factor and is subject to fairly frequent starting and stopping.

Stations B and C reheat their steam, the first station between the seventh and eighth stages, and the second station between the fourteen and fifteenth stages. In station B the reheat boilers are operated to maintain the desired reheat temperature to the low-pressure stages of the turbine. If the turbine overspeeds, a trip closes the throttles on both the high- and low-pressure sections—the latter to prevent additional overspeeding from sudden expansion of the steam stored in the reheat boilers. Overspeed tripping also slows down the induced-draft fans on the reheat boilers, cuts out the forced-draft fans, and opens the ventilators on the furnace. No large changes in the reheat temperatures have been experienced with fluctuations in load, even without furnace adjustment. No automatic provision is made to control the reheat temperature when the load drops or fluctuates, hand control being considered adequate and no hardship. The net benefit of reheating the steam to the lower stages has been approximately 4 per cent over the entire range of load, according to this company; besides, the erosion of turbine blading from wet steam is largely eliminated.

At station C it is planned to keep the load uniform on the main unit, and the reheat temperature will be maintained by hand control of the reheat furnace. Although automatic features are not favored at the present time, provision has been made so that if the unit loses its entire load, the coal feed to the reheat furnace can be automatically shut off and the furnace vents opened. As in station B, it has been found that the reheat temperature does not fluctuate considerably with changes in load, and that hand control is adequate to take care of any operating conditions.

Besides reducing the flue-gas losses, air preheaters so improve combustion that the actual gain is considerably greater than the saving in flue-gas losses. Apparently chain-grate stokers burning the poorer grades of coal may be expected to show a greater gain from the use of preheated air at a given temperature than can underfeed stokers burning a very good grade of coal with air at the same temperature.

At station B, where forced-draft chain-grate stokers are used to burn very poor coal, the air preheaters, which are of the plate type, have been so effective for the price installed that plans are being made to install air preheaters on the second group of boilers, which were not so equipped originally. The preheaters reduce the economizer gas-outlet temperature 65 to 110 deg., depending on the load conditions. No corrosion of the plates in the air preheaters results if the boiler load is not allowed to drop so low that the stack temperature is reduced to the point where dew forms on the plate. (Report of a committee of the National Electric Light Association, entitled Experiences with Modern Stations, abstracted through *The Electrical World*, vol. 87, no. 19, May 8, 1926, pp. 983–993, illustrated, *pA*)

RAILROAD ENGINEERING

New Engines on the Road

Many railroads are buying the modern types of locomotives, which are more efficient than most of the existing power, only to find that the new engines are not delivering the service expected of them. Usually a study of operating conditions will reveal that this is not the fault of the engine but is due, rather, to some antiquated operating practice on that particular road. Most of the new engines of today are capable of handling heavier trains at higher speeds than was possible a few years ago. The result is that the use of a number of new engines on any road usually requires a complete reorganization of operating methods. That is, increased speeds must be expected; longer passing tracks will be needed; more efficient terminal operation must be had; and methods of despatching and train running must be changed, if a full measure of service is to be obtained. This may appear as an order of considerable magnitude, but many railroads are doing it, and they are deriving untold benefits in the way of increased revenues and lower operating costs. (Editorial in *Railway Review*, vol. 78, no. 21, May 22, 1926, p. 910, *g*)

An Automotive Train with Mechanical Drive

Description of a new type of automotive train with the central power unit driving all axles.

The motor car contains the power plant and space for passengers and baggage, the engine room being at the forward end of the car. The engine is of the automotive type with six $5^3/_4$ by $7^1/_4$-in. cylinders and overhead valves, developing 175 hp. at 1300 r.p.m. One of the features of this engine are hollow machined connecting rods. Double and dual ignition are provided by means of two spark plugs in each combustion chamber and by a Bosch high-tension magneto and Putnam storage batteries. The clutch mounted in the bell housing of the engine is positively ventilated by means of the ratchet starting bar, teeth of the flywheel, and suitable holes in the housing. A control staff is at the left of the engineer and contains the engine throttle lever, spark-control lever, electric-starter switch, pneumatic-starter lever, and the complete ignition control. The starter switch and ignition are safeguarded by locked switches which have to be turned on with a key before it is possible to obtain current for either starting or ignition.

To transmit the engine power to the trucks the following arrangement was developed. It is constructed in three sections, all of which are joined together into one complete assembly, and provides for four speed ratios in both forward and reverse drive to both trucks. The drive shaft from the clutch casing on the engine connects to the reverse-gear compartment, which permits the driving torque to be delivered to the adjacent change-speed gear box in either direction of rotation. Forward or reverse motion is obtained by means of suitable gear-shifting mechanism. The four-speed-gear compartment is of conventional arrangement, and the selection of the proper ratio made by means of the gear-shift lever and quadrant located at the right of the engineer. From the change-speed gear box the driving energy is delivered to a transfer and compensating-gear chamber. It is necessary to drive both fore and aft from this compartment, also to compensate for drive-wheel slippage or a difference of drive-wheel diameter between the two trucks, therefore a differential of rather unusual construction is incorporated in this compartment, from which the power is delivered through suitable drive shafts running fore and aft to the two trucks of the car.

In this way a positive drive is delivered to each of the four axles in the two motor-car trucks, and the drive as between trucks is compensated for through the medium of the differential in the rear compartment of the transmission. This provision was incorporated so that if the four wheels of one truck were turned or worn to a different size from that of the wheels of the other truck of the car, no slippage would result. Each axle under the car is a driving member. Universal joints are placed so that their curvature does not interfere with the delivery of power to the trucks. There are a number of other interesting features described in the original article, but which cannot be reported here owing to lack of space. (A. W. Scarratt, Mechanical Engineer, Minneapolis Steel & Machinery Co., in a paper presented April 23, 1926, before the Chicago Section of the Society of Automotive Engineers; abstracted through *Railway Review*, vol. 78, no. 21, May 22, 1926, pp. 911–915, illustrated, *d*)

Cinders as Locomotive Fuel

In the last few years remarkable improvements have been made by the railroads in the conservation of fuel. It seems, however, that still greater savings may be possible by employing means that are comparatively new when contrasted with those used in the past.

The Boston & Maine has under construction a plant for reclaiming coke from locomotive ashes. This reclaimed fuel is to be used for station-heating purposes, and it is estimated that a saving of approximately 30,000 tons of coal a year will be effected.

German engineers have found that by mixing cinders collected in locomotive smokeboxes with good coal it is possible to effect a considerable saving in the consumption of fuel, and it is estimated in this connection that the average saving from the use of this reclaimed fuel on German railways will amount to approximately \$1,300,000 annually. Tests conducted in the burning of such fuel on German railroads indicate that the fuel has a heating value of 8100 B.t.u., and that an average evaporation of 7.06 lb. of water may be obtained per pound of fuel.

The plant of the Boston & Maine is reported to be the first of its kind in this country, and no doubt if its operation is as successful as is anticipated its introduction will mark the beginning of a new period in the conservation of fuel. Moreover, it seems that if this fuel is suitable for use in stationary power plants, it would be reasonable to assume that a certain portion mixed with good fuel might also be serviceable for use on locomotives.

About the only use for cinders and ashes from locomotives in this country is for ballast and filling. If the German railways can save approximately $1,300,000 a year by using coke reclaimed from ashes as fuel, and if the Boston & Maine realizes a saving of 30,000 tons of coal a year, it would seem possible that the more general use of these two methods would effect material savings on all railroads. (Editorial in *Railway Review*, vol. 78, no. 18, May 1, 1926, p. 796, *g*)

SPECIAL PROCESSES

A Modernized Oil Refinery

DESCRIPTION of the refinery of the Pierce Petroleum Corporation at Sand Springs, Okla., which is representative of the most progressive tendencies in the oil industry.

Pipe Still. It is said that the design and construction of pipe stills is an open game which offers the greatest opportunities for engineering skill in solving the distillation problems of the oil refiner. At the Pierce plant there are two identical units in the topping plant, each of which is able to handle 3500 to 4000 barrels of crude oil per day, yielding about 60 per cent of the total charge in three overhead products—gasoline, kerosene, and gas oil. By a slight modification of the usual procedure, it is possible to obtain in

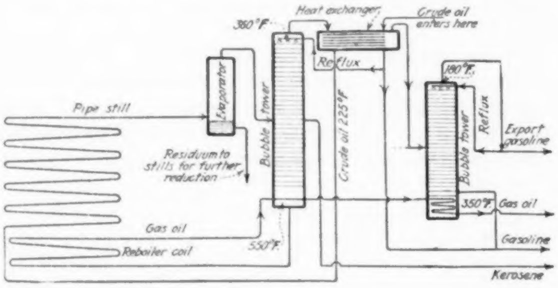

FIG. 6 A SCHEMATIC LAYOUT OF EQUIPMENT IN ONE OF THE TWO PIPE-STILL TOPPING UNITS

a single operation the so-called export gasoline having a gravity of 64 to 65 deg., as well as the usual product of new Navy specifications.

The operation of the pipe still and the interesting layout of the evaporator, fractionating tower, and heat-exchanger units may be observed from the diagrammatic sketch of Fig. 6. It will be noted that the crude oil enters the system through a Griscom-Russell vapor heat exchanger where its temperature is raised to approximately 225 deg. fahr. by the vapors from the top of the first bubble tower. It then enters the pipe still, each unit of which contains 154 tubes, 4 in. in diameter and 20 ft. in length, arranged in the furnace in the form of two coils. The vapors leave the furnace at 600 to 650 deg. fahr., and pass into an evaporator and then to the bubble tower, which is entered at one of the lower plates. About midway up the tower the kerosene fraction is withdrawn. From the bottom of the column, which is at a temperature of about 600 deg. fahr., a portion of the gas oil is withdrawn and further heated by passing through the reboiler coil in the furnace. It is then returned to supply additional heat at the bottom of the bubble tower in order to obtain close fractionation between the end point of the kerosene and the initial boiling plant of the gas oil. The remaining gas oil flows through a closed coil in the base of the second bubble tower where it provides additional heat for fractionation, and finally passes through cooling coils to storage.

The gasoline vapors that leave the top of the first bubble tower are at a temperature of about 360 deg. fahr. and as these pass through the vapor heat exchanger, in order to raise the temperature of the crude, a portion is condensed into gasoline. The uncondensed gasoline vapor passes off into the second bubble tower where it is fractionated into export gasoline and gasoline, the export gasoline being withdrawn from the top in vapor form and the gasoline being condensed and passing away at the bottom. The condensed gasoline from the vapor heat exchanger is partly utilized as a reflux at the top of the first bubble tower, the temperature of the gasoline vapors being automatically regulated and controlled by the amount of reflux being pumped over. In order to obtain the necessary end point on the export gasoline a portion of the condensed product is refluxed over the top of the second bubble tower, the quantity being regulated, as in the first tower, by automatic temperature controls.

In fact, a noteworthy feature of this installation is the many uses of automatic control devices which greatly simplify the manual operation of the plant. Practically the only operating adjustment required is that on the fuel valves of the furnaces. Leeds and Northrup potentiometer-type instruments are used to record temperatures at various important stages in the process, and the control of fractionation is by Tycos temperature-regulating devices that automatically control the rate of reflex material at the top of the bubble columns. Charging and transfer pumps, which are housed beneath the condensers, are controlled by automatic float valves. (S. D. Kirkpatrick, Assoc. Editor, in *Chemical and Metallurgical Engineering*, vol. 33, no. 5, May, 1926, pp. 270–273, 7 figs., *d*)

TRANSPORTATION

The Future of Air Transport

THE FUTURE development of commercial air transport cannot be other than highly speculative, but as a result of the experience gained in the last few years, it is clear that for certain services, such as mail carrying, no nation can afford to disregard its possibilities. It is unnecessary to stress the special importance of the problem in the case of the British Empire, the constituent units of which are so widely scattered, and it is somewhat regrettable that, as regards this aspect of aviation, Great Britain does not occupy the position, as compared with other nations, that might have been expected to result from its admitted supremacy in fighting and reconnoitering craft during the war. The British present position was surveyed by Air Vice-Marshal Sir W. Sefton Brancker, in delivering the fifth Gustave Canet lecture before the Junior Institution of Engineers on April 30, and a few figures quoted from this address will serve to illustrate the present position.

Practically the whole of the British, French, German and other services may be said to have been run at a loss, as they are maintained, with one small exception, by the aid of government subsidies. The only case in which a service pays its way without artificial assistance is that from the coast up the Magdalena River to Bogota, in Colombia, the reason in this case being that at times it is the only practicable means of transit. The subsidies paid or voted in 1925 in England, France, and Germany respectively were £137,000, 57,210,000 francs, and 6,700,000 gold marks, and it is evident that such subsidies cannot be continued indefinitely. The future of commercial air transport is clearly bound up in the possibility of reducing operating costs to an economic level, and a discussion of the prospects in this direction constituted one of the most interesting features of Sir Sefton Brancker's address.

Sir Sefton stated that the present total cost of carriage by air is about 5 shillings per ton-mile at 90 m.p.h. In his opinion, such a charge is very high but not impossible for passenger traffic and it can be accepted as a legitimate charge for carrying first-class mail matter at high speed. It is, however, too high a figure to attract any considerable volume of freight. The principal items of expenditure may be divided in the usual way into overhead charges and operating costs, the former being subdivided into interest on capital, obsolescence and depreciation, and insurance. Operating costs may be subdivided into maintenance of engines, maintenance of aircraft, and fuel.

Dealing with those divisions in order, the most important point associated with interest on capital is the number of machines required to maintain any given service. Sir Sefton Brancker mentioned in the course of his address that a machine should be able to spend 2000 hr. a year in the air on day flying alone, but that owing to the exigencies of present traffic requirements, an average of 1000

hr. per year must be considered good. Figures were given for individual machines of the Imperial Airway fleet during June, 1925, and as an example of actual service it may be mentioned that one machine flew 47 times in the month on the London-Paris journey of 225 miles, in addition to several trips on other routes. Another machine covered 900 miles a day on 19 days included in a period of six weeks. The number of hours flown per year is limited by the necessity of waiting for foreign connections, and a material improvement would result if the services could be extended to avoid this necessity. There is a good prospect of this being achieved, as the difficulties of carrying services beyond the frontiers of Germany are being overcome. There is also a prospect of reducing the initial cost of machines, but up till the present any reductions in production costs have been largely offset by additional equipment tending to increased safety, of which the adoption of three engines per machine is typical.

On the questions of depreciation and obsolescence, Sir Sefton stated that sufficient experience has not been obtained to lay down a fixed rate of depreciation, but that any figure to cover this factor would be very small in comparison with that for obsolescence.

The third item in overhead charges, that of insurance, has been a heavy drain on operating companies up till the present. Rates are high for two reasons: first, the volume of business is very small, and second, a crash involving no danger to life may damage a machine very badly. Business, however, is increasing, while damage resulting from bad landings and so on has been reduced, with the result that insurance rates, averaging from 20 to 30 per cent per annum in the last six years, have now fallen to $7^1/_2$ per cent for three-engined machines, with somewhat higher figures for other types.

Turning next to operating costs, Sir Sefton gave an analysis of the figures for 1925 with the following results. Engine maintenance 44 per cent, aircraft maintenance 20 per cent, fuel 30 per cent, and miscellaneous costs, including flying pay, 6 per cent. Engine maintenance may be divided broadly into the cost of spares and the cost of man-hours required to keep the engine running. The former is high, and may be taken as roughly proportional to that of the engine itself. In the case of water-cooled engines, the cost of an engine is about £5 9s. per hp., but the corresponding of figure for air-cooled engines is only £3 15s. Apart from initial cost, it is interesting to note when comparing the two types that in 1925, 20 per cent of the defects leading to the removal of engines from the craft of the Imperial Airways, were due to the water system. Of the other defects leading to the removal of engines, valve breakage or distortion represented 31 per cent, failure of the oil circulation 10 per cent, failure of material 19 per cent, and other defects 28 per cent.

The ultimate success of commercial air services obviously depends on the extent of the confidence of the public in this means of transport, and we may conclude our review of Sir Sefton Brancker's address with some further extracts bearing on this point. Taking the period from May, 1919, to December, 1925, the mileage flown on recognized British transport services was 4,431,000. There were four fatal accidents, in which 13 passengers were killed and five passengers injured. There were no fatal accidents in 1925, and it is probable, in view of the recent adoption of additional safety devices, that in the future the very low average over the last seven years will be still further reduced. The most important additions to the machine from the point of view of safety have been the employment of three engines, already referred to, and various arrangements for reducing the stalling speed. Concurrently with these improvements, methods of navigation have also been improved, and it is not too much to say that the danger of accident may now be regarded as practically negligible. (Editorial in *Engineering*, vol. 121, no. 3149, May 21, 1926, pp. 598–599, *g*)

WELDING

The Strength of Electrically Welded Pressure Vessels

ABSTRACT of a book, the major part of which is devoted to the question of the strength of welded joints. The pieces on which the tests were carried out were merely welded and not riveted. They lacked, therefore, the bending strains produced by riveting and also the reinforcement due to it, so that the conditions prevailing in the test pieces were somewhat different from those met with in boilers of conventional construction. The original article points out that the round seams of bodies subject to strains should not be weakened, the value of this information lying in the fact that frequently sufficient attention is not paid to the fact that the round seam holding the head eventually may become the weakest part of the whole boiler.

To determine stresses, measurements of elongation over stretches of 20 mm. were made on the exterior of the vessel by means of an Okhuizen extensometer. From this the stresses were calculated using as coefficients of elongation $\alpha = \frac{1}{2,150,000}$. In the course of these measurements there was often observed a transition from tension to compression stresses.

Data of calculations for elliptically dished heads with various ratios of axes (this being so in order to obtain different kinds of flanges) are presented in Fig. 8 in which the radii of flanges have been plotted as abscissas and the maximum peripheral stresses as ordinates. The peripheral stress at the summit of the elliptical meridian is expressed by the formula

$$\sigma_u = \frac{a \times k}{2s}\, p$$

where a is the longer axis, k the ratio of the two axes, s the wall thickness, p the radius of curvature at the crown of the longer axis, which means that $p = a/k^2$. From this it would appear that the peripheral stress increases with the increased flattening out of the ellipse, the result being a curve showing that as the curvature at the flange decreases (in so far as one may speak of this in the case of heads with an elliptical meridian) the strain rapidly increases (a pressure strain on the external side of the head). The value 2.0 plotted in Fig. 8 corresponds to a head with $a : b = k = 2$, which represents the so-called Diegel head, recommended from the point of view of pressing on the head. Where the radius of the flange is equal to 0.1 or 1 : 20 of the diameter [Exact translation of the original. Editor], Fig. 8 shows a stress four times as great as in the case of a head where $a : b = 2$. The scale of Fig. 8 differs from that of Fig. 7, however. In conclusion, attention is called to the fact that the tensile stresses inside of the flange are greater. As regards the bending stresses, the measurements were carried out on the assumption that the meridional stresses are to be preferred to the calculated peripheral stresses.

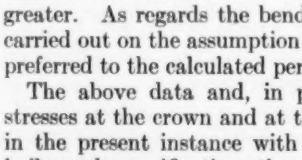

Fig. 7

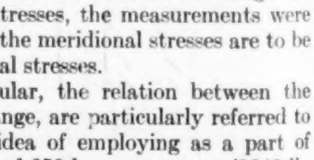

Fig. 8

FIG. 7 STRESSES k_w IN A BOILER HEAD FOR VARIOUS SHELL DIAMETERS d AND VARIOUS FLANGE RADII r

FIG. 8 MAXIMUM PERIPHERAL STRESSES σ_u FOR VARIOUS FLANGE RADII

The above data and, in particular, the relation between the stresses at the crown and at the flange, are particularly referred to in the present instance with the idea of employing as a part of boiler-code specifications the value of 650 kg. per sq. cm. (9243 lb. per sq. in.) for measuring the wall thickness in the flange. Concerning the Strength of Electrically Welded Hollow Pressure Vessels (Ueber die Festigkeit elektrisch geschweisster Hohlkörper), by Chief Engr. E. Höhn, 1924, Julius Springer, Berlin. Abstracted through article published in *Zeitschrift des Bayerischen Revisions-Vereins*, vol. 30, no. 8, Apr. 30, 1926, pp. 100–101, 2 figs., *p*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Engineering and Industrial Standardization

Recent Developments

Woodruff Keys

ON MARCH 26 the Sectional Committee on the Standardization of Shafting and the A.S.M.E. Standardization Committee held a conference with the manufacturers and users of Woodruff keys concerning a proposal to standardize and simplify this type of fastening. The conference agreed that this project should go forward by a new sub-committee organized under the auspices of the Sectional Committee on the Standardization of Shafting.

In the fall of 1923 the Society of Automotive Engineers appointed a subdivision to study this subject and to recommend a selected list of Woodruff keys for use in automotive applications. Later the *American Machinist* conducted an investigation of the same subject.

In Detroit on May 12 this Sub-Committee held its organization meeting and immediately took up the task assigned to it. The preliminary report, which will soon be distributed for criticism and comment, covers (*a*) standard sizes, being a simplified list, (*b*) radii of keys, (*c*) height of keys, (*d*) width of keys, and (*e*) depth of slots in shafts. Copies of this preliminary report in pamphlet form will soon be available.

T-Slots and Parts

The first Sub-Committee organized under the sponsorship for the Standardization of Small Tools and Machine-Tool Elements was that for T-slots. This Sub-Committee has been at work since April 24, 1924, and after drafting and redrafting its report a number of times is now considering a final draft in printer's-proof form.

The proposed standard will now be sent to the technical press and to the members of the sponsors' committee for publication and review prior to formal submission to the sponsor bodies and transmission to the American Engineering Standards Committee. Copies may be obtained by those interested on application to C. B. LePage, 29 West 39th Street, New York.

It should be stated here that in May the Society of Automotive Engineers accepted the invitation of the A.E.S.C. to become joint sponsors with the National Machine Tool Builders Association and The American Society of Mechanical Engineers for the standardization of Small Tools and Machine-Tool Elements.

Standards for Gear-Tooth Form and Nomenclature

The first report of the Sectional Committee on the Standardization of Gears to reach the status of letter ballot is that of Sub-Committee No. 4, Henry J. Eberhardt, Chairman. This proposed standard includes the basic proportions of the rack for the $14^1/_2$-deg. composite tooth and the rack for the 20-deg. stub tooth.

Upon the completion of the letter-ballot this standard will be submitted to the sponsor bodies for their approval and transmission to the American Engineering Standards Committee for approval and designation as American Standard. Page-proof copies are now available to those specially interested in it, on application to C. B. LePage, Acting Secretary of the Sectional Committee, 29 West 39th Street, New York.

Sub-Committee No. 3, Edward W. Miller, Chairman, has made good progress toward the development of a set of symbols and abbreviations for use in computations on gears and gearing. The committee recently sent out a questionnaire on the subject, to which were attached copies of alternate proposals. All those interested in this subject are urged to communicate with Chairman Miller through the above address.

Standards for Plain Taper and Gib-Head Taper Keys

For some months a Sub-Committee of the Sectional Committee on the Standardization of Shafting, Cloyd M. Chapman, Chairman, has been at work on the standardization of plain taper and gib-head taper keys. After a preliminary distribution in blueprint form to a short list of interested individuals, these proposed standards were carefully revised by the Sub-Committee, J. E. Bushnell, Chairman. They are now in page-proof form and are being further distributed to manufacturers and large users for criticism and comment.

Those desiring to assist in perfecting these proposed Tentative American Standards may secure copies of them by addressing the Chairman of the Sub-Committee, care of the A.S.M.E.

Bolt, Nut, and Rivet Proportions

The work of the several sub-committees of the Sectional Committee on the Standardization of Bolt, Nut, and Rivet Proportions has progressed rapidly during the past few months.

The proposed standards for Small Rivets and Tinners', Coopers' and Belt Rivets, prepared by Sub-Committee No. 1, Lieut. H. N. Wallin, Chairman, are now in page-proof form and are being voted on by the members of the Sectional Committee.

The proposed standard for Wrench-Head Bolts and Nuts and Wrench Openings received a practically unanimous vote of the Sectional Committee and is now before the sponsor bodies for approval. They have published it in their monthly journals as part of the required procedure. Lieut-Comm. J. B. Rhodes is chairman of the sub-committee that developed this standard.

The report of Sub-Committee No. 5 on Round Unslotted Heads (carriage bolts), W. M. Horton, Chairman, was recently distributed in page-proof form. Letter-ballot on this standard by the members of the Sectional Committee is now in progress.

The final draft of the proposed standard for Plow Bolts was mailed to the members of the Sectional Committee for letter ballot on April 27th. This is the standard which was approved in preliminary form at the conference held in Washington on February 19 and 20, 1924, and called by the Division of Simplified Practice of the Department of Commerce.

Standardization of Machine Tapers

The Sectional Committee on the Standardization of Small Tools and Machine-Tool Elements, which is sponsored by the National Machine Tool Builders Association, the Society of Automotive Engineers, and The American Society of Mechanical Engineers, held a conference on the standardization of machine tapers in Providence, R. I., on Wednesday afternoon, May 5, 1926.

For some years this project has been discussed by the members of the three sponsor organizations, and during the past four or five years they have received from the European countries a considerable number of inquiries concerning American practice in regard to Brown and Sharpe, Morse, and Jarno tapers. With the inquiries from Switzerland, Sweden, and Germany were enclosed standard sheets which indicate that these countries have in some cases established for themselves standard dimensions for tapers similar to those in use in this country.

For many reasons, therefore, it seems desirable that the interested representatives of American industry should consider this subject seriously for the purpose of establishing one or more series of standard tapers. These standards could then be presented to the American Engineering Standards Committee for approval as American Standards.

At the May 5th Conference the subject was discussed freely and the Conference finally recommended that a sub-committee be appointed to study this subject and to proceed with the standardization if that seems to be practicable.

Lathe and Planer Tool Holders

The second Sub-Committee to be organized under the sponsorship for Small Tools and Machine-Tool Elements is developing standards for Tool Holders and Tool-Post Openings. The Committee was organized and elected temporary officers on March 25 in New York, and on June 10 in Buffalo it discussed at length a preliminary draft of its first report which had been outlined at the March 25th meeting

and completed by a Sub-Committee meeting on the afternoon of the same day.

An analysis of a representative group of tools and bit holders was made with regard to three specific dimensions, namely, the depth of the shank cross-section, the width of the shank cross-section, and, in the case of lathe tools, the elevation of the bit or cutting point above the base or bottom plane of the tool.

This analysis shows a close agreement to a general average in each of these dimensions, for any tool picked at random from the several manufactured styles. The graphs representing these general averages follow logarithmic curves indicating that present design follows some system of preferred numbers.

Since present tool design is fairly uniform and systematic, it was decided that the new standard had best follow it closely. It was also felt that if a standard line of tools was developed it would serve in place of and be much more easily expressed than a standard for tool posts and holders.

In order to make the restriction of design by the standardization as light as possible, no definite shank sizes are recommended, but instead, a maximum metal value for each size. This will allow the tool manufacturer some latitude in the selection of rolled sections of bar stock, design of forging dies, and the sizes of shank after a finish machining.

Standards for Plain and Lock Washers

At the direct request of the U. S. War Department, the American Engineering Standards Committee took the necessary steps under its procedure to authorize the organization of a Sectional Committee for the purpose of standardizing Plain and Lock Washers as part of a group of small machine parts in need of standardization and simplification. The Society of Automotive Engineers and The American Society of Mechanical Engineers have accepted joint sponsorship for this project, and on March 19 the Committee held its first or organization meeting.

Lieut. Victor E. Bertrandias, representing the U. S. Army Air Service, was elected temporary chairman, and H. A. Hoke, representing the American Railway Association, temporary secretary.

The Committee voted that the scope of its work should include the standardization of (*a*) punched washers, (*b*) lock washers, (*c*) malleable-iron washers, and (*d*) cast-iron washers.

Three sub-committees are now being organized to collect data and to draft preliminary reports for consideration at the next meeting to be held early in the fall.

Standards for Straight, Taper, Split, and Dowel Pins

Under the same sponsorship as that for Plain and Lock Washers a Sectional Committee was organized on March 19 to take up the standardization of Straight, Taper, Split, and Dowel Pins for use in general machine-shop practice. When finally completed the personnel of this Committee will be broadly representative of the manufacturers of these products (producers), those who use them in the manufacture of their machines and parts (consumers), and a group of independent specialists (general interests).

After discussing the project in some detail the Committee decided to postpone the election of officers until the next meeting, but voted that the work shall be divided between two sub-committees, one on Straight, Taper, and Dowel Pins, and the other on Split Pins of all kinds.

Safety in Textile Industry

UPON the request of the Safety Code Correlating Committee the American Engineering Standards Committee authorized the organization of a Sectional Committee on a Safety Code for the Textile Industry. The National Safety Council and the National Association of Mutual Casualty Companies accepted joint sponsorship and the Committee held its organization meeting on March 17, 1925. It now numbers 20 members representing 15 organizations. Charles H. Eames was elected chairman, and W. Dean Keefer, secretary.

Soon after its first meeting the following three sub-committees were formed and elected the officers named below:

Sub-Committee on Woolen and Worsted Mills
Chairman, E. F. King; Secretary, Ignatius MacNulty

Sub-Committee on Cotton Mills
Chairman, J. A. Perkins; Secretary, W. Dean Keefer

Sub-Committee on Dyeing and Finishing
Chairman, K. G. Reed; Secretary, Harvey Saul.

The Sub-Committee on Cotton Mills has completed the first draft of its report, and it was recently distributed broadly for criticism and comment. Copies may still be obtained by addressing W. Dean Keefer at the National Safety Council, 108 East Ohio Street, Chicago, Ill. It is expected that preliminary drafts of the sections of the Code covering Woolen and Worsted Mills and Dyeing and Finishing will soon be available. When these are on the way other Sub-Committees will be formed to develop the sections on Silk Mills, and Cordage Mills.

The Annual Accident Toll and Its Cost

ACCIDENTS on the streets, at home, and throughout industry during the past year killed more than 85,000 men, women, and children, injured between five million and ten million persons, and cost America approximately $5,000,000,000.

Our total accidental fatality rate is more than twice as great as that of England and Wales, and nearly 50 per cent greater than Canada's, which is next on the list. Not only do we exceed all other countries for which records are available in automobile fatalities, owing to our much higher automobile registration per capita, but we likewise exceed them in the fatality rate from such other common causes as falls, burns, and steam and electric railroads, while our drowning rate is exceeded only by Canada and by such maritime countries as Scotland, New Zealand, Australia, and Norway.

Despite these unfavorable comparisons, it is worth noting that our total accident death rate in recent years has been about 10 per cent below the average for the first decade in this century. In almost all the common classifications there has been so definite a decrease, especially in the case of railroad and drowning accidents, as more than to neutralize the very rapid increase in automobile fatalities, says S. J. Williams, director of the Public-Safety Division, National Safety Council. The total number of accidental deaths in the United States from 1907 to 1923, inclusive, was 1,343,384, according to the Census Bureau. If accidental deaths had occurred each year at the same rate per 100,000 population as in 1907, the total would have been 1,580,825. This represents a saving, in 16 years, of 237,441 as compared with the 1907 rate, despite the fact that the number of our automobile deaths was 100,460 more than it would have been at the 1907 rate.

The same calculation has been made, starting with 1913, showing that the actual number of accidental deaths was less by 93,071 than would have been the case if the 1913 rate had continued to and including 1923, despite the fact that the number of automobile deaths during the same period was 58,119 greater than it would have been at the 1913 rate.

Corrections

Page 664 of the Supplement to the June issue, second column, 16th line from bottom: For 1926 read 1916. However, we are informed by the author, Mr. Thilenius, that even this latter date is erroneous, since 85-hp. engines were used as early as 1907.

Page 678, first column, 17th line from top: For z read μ, and in the following line delete ϕ. In the second column, 5th and 6th lines, for u read w.

Page 681. Turn Fig. 14 so that the tubes will be horizontal and the bottom as printed will be at the right in the new position.

Page 577 of the June issue: Near the close of Mr. Black's discussion of Mr. Dichman's paper on Maintenance and Depreciation of Airplanes, his total figure on airplane operation was given as fifty cents per airplane mile. This sentence should have read: "Mr. Black's figure on operation, including all costs *except capital charges*, worked out at about *$1.65* per airplane-mile."

Page 500 of the May issue: First column, 15th line: For "reasonable," read "unreasonable." In the 33d line Mr. Bull is incorrectly referred to as Mr. Hall.

Correspondence

***CONTRIBUTIONS** to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on activities or policies of the Society in Research and Standardization.*

Deflection of a Shaft at the Critical Speed

To the Editor:

I find myself in disagreement at many points with Prof. John A. Dent's paper under the above title, published in Mechanical Engineering for September, 1925, and believe the matter important enough for a detailed discussion, point by point.

The Problem Referred to a Stationary System of Axes. In Fig. 1, let XOY be a system of fixed axes in a plane at right angles to the line joining the center of the journals. O is the projection of this line on the plane XOY. Q is the center of the shaft where it passes through the disk, so that PQ is the eccentricity and OQ the deflection of the shaft.

The only real forces acting on the disk are the elastic reaction F of the shaft and the external couple T which is to accelerate it to full speed. According to elementary dynamics, a body moves as if all of its mass were concentrated at its center of gravity and all external forces were transposed parallel to themselves to the center of gravity. In transposing F from Q to P we introduce a couple aF, and thus the forces to be considered are a force F acting at P, and a resultant couple $T + aF$. Again, by elementary dynamics we know that a couple can only cause rotation of the body around its center of gravity. And if we agree to so regulate the couple T which is applied from the outside that $T + aF$ is constant at all times, the disk will rotate around its center of gravity with a given constant angular acceleration denoted by α. The rotation of the disk around its center of gravity P is therefore known, and hence the problem consists solely in determining the motion of translation of P under the action of the force F.

If after the lapse of t seconds P has moved to P', the new configuration of the system is determined as follows: The eccentricity PQ is a line on the disk and rotates with it. In t seconds it rotates through an angle $\varphi = \omega t + \alpha t^2/2$, where ω is the angular velocity of the disk in the configuration OPQ. Through P' we draw a line parallel to PQ and lay off with respect to it the angle φ. Then, making $P'Q' = PQ$, the new configuration of the system will be $OP'Q'$.

The Problem Referred to Rotating Axes. Instead of stationary axes of reference, Professor Dent prefers to have them rotate in exact synchronism with the disk. The nature of the problem, however, remains the same. As before, there is rotation of PQ around P with the given angular acceleration α and a translation of P, but now these motions are to be referred to a plane rotating around O. Let us dispose of the rotation first and let OPQ, Fig. 2, be the configuration of the system relative to the rotating plane of reference at the time t. An observer rotating with this plane around O in exact synchronism with the rotation of PQ around P cannot of course detect any angular displacement of PQ. That is to say, with respect to this rotating plane of reference, PQ always remains parallel to itself. As to the translation of the center of gravity P of the disk, it will trace relatively to the rotating plane of reference a trajectory such as $PP'P''$. When the center of gravity is at P' the new configuration $OP'Q'$ of the system will be obtained by laying off $P'Q'$ parallel and equal to PQ.

Relative Velocity of P as Defined by Professor Dent. Quoting from Professor Dent's paper: "The components of the velocity of P relative to a plane rotating about O with the angular velocity and acceleration of the disk are dS/dt radially and $Sd\beta/dt$ tangentially."

If Professor Dent will refer to Fig. 2 of this discussion he will note the obvious fact that *both OP and OQ move* relatively to his rotating plane of reference. The angle β is therefore *not* a measure of the angular position of the radius vector OP with respect to the plane of reference and $Sd\beta/dt$ is consequently *not* the tangential component of the relative velocity of P.

Dynamics of Relative Motion. The object of the problem now is to determine the translation of the center of gravity P of the disk relative to a plane rotating round O with the angular acceleration α and velocity ω.

According to Professor Dent, the accelerations are:

(1) The acceleration of $Y\omega_c^2$ due to the elastic reaction of the shaft

(2) A radial component $S\omega^2$ in the direction PO

(3) A tangential component $S\alpha$ perpendicular to PO in the direction of the angular acceleration

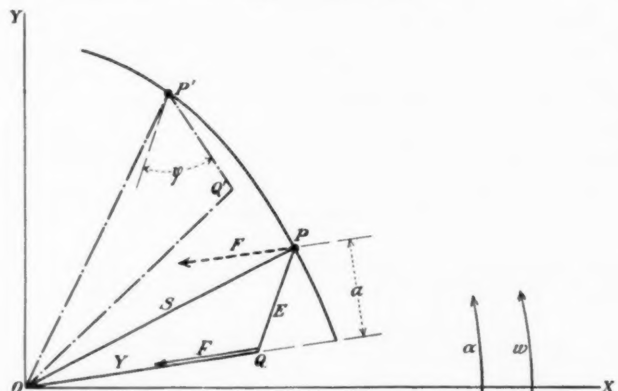

FIG 1.

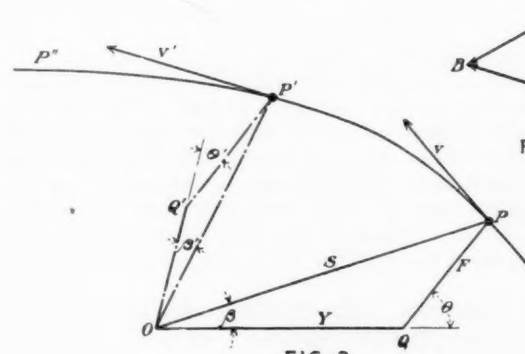

FIG. 2.

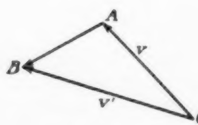

FIG. 3.

Fig. 1 Problem Referred to Stationary Axes. PQ Rotating Around P with Angular Acceleration α. When P Arrives at P', PQ Has Rotated Through Angle φ

Fig. 2 Problem Referred to Axes Rotating Around O in Synchronism with Rotation of PQ About P. Relative to These Rotating Axes, PQ in Any Other Position $P'Q'$ Remains Parallel to Itself

Fig. 3 Determination of Relative Acceleration

(4) A radial component in the direction OP, d^2S/dt^2

(5a and 5b) The Coriolis components, $2\omega Sd\beta/dt$ and $2\omega dS/dt$.

I am in agreement so far as (1), (2), and (3) are concerned. One of the Coriolis components, (5a), is wrong, however, since, as remarked previously, $Sd\beta/dt$ is not the tangential component of the relative velocity of P.

On further consideration it is apparent that Professor Dent's acceleration d^2S/dt^2 stands for the acceleration of P relative to the plane of reference, and this is also wrong. For, if (Fig. 2) OPQ and $OP'Q'$ are the configurations of the system at the times t and $t + \Delta t$, and v and v' are the relative velocities of P, the relative acceleration is determined as follows: If through a point O (Fig. 3) we draw OA and OB parallel and equal to v and v', the relative

acceleration in magnitude and direction will be $AB/\Delta t$ and not d^2S/dt^2, nor will it be directed along OP as Professor Dent has it.

Professor Dent's Equations of Motion. Of course Professor Dent is at liberty to resolve his accelerations in any two directions he may choose, but the axes selected, whatever they may be, must be lines fixed in his plane of reference. Now the directions selected by Professor Dent for the resolution of his accelerations are OP and a direction he calls vertical, which I take to mean perpendicular to OQ (Fig. 2). However, as shown in the early part of this discussion, both OP and OQ are *not* lines fixed in the plane of reference but *move relatively to it.* And so Professor Dent's equations of motion [2], [3] and [5], even if his accelerations had been correct, are meaningless.

A Simple Check of Professor Dent's Equations of Motion [2] and [3]. When the eccentricity $OQ = 0$, which is not a mathematical abstraction but a case which may readily occur in practice, $Y = S$ and $\beta = 0$. The absolute translation of P is then that of a mass on a shaft which receives a displacement and is then let go; that is to say, a transverse vibration with the circular frequency ω_c. Viewed from or relative to a rotating system of axes, the translation of P must be the above vibration on which is superposed the rotation of the reference plane. The rotation of the disk around its center of gravity remains as before. Thus we know beforehand the results which must be obtained if Professor Dent's equations of motion [2] and [3] are correct.

Substituting $Y = S$, $\beta = 0$, $d\beta/dt = 0$ in the above we have:

$$S\omega_c^2 = S\omega^2 - \frac{d^2S}{dt^2} \quad [2a] \qquad \text{and} \qquad S\alpha + 2\omega\frac{dS}{dt} = 0 \quad [3a]$$

With α constant and the disk starting from rest $\omega = \alpha t$, which substituted in the above gives:

$$S(\omega_c^2 - \alpha^2t^2) = -\frac{d^2S}{dt^2} \quad [2b] \qquad \text{and} \qquad S + 2t\frac{dS}{dt} = 0 \quad [3b]$$

The integration of [3b] gives immediately

$$tS^2 = A^2$$

wherein A is a constant of the integration.

It will be seen that this result does not satisfy [2b] and is certainly very far from stating that the translation of P is a vibration along OP and a rotation superposed on it. That the errors committed are fundamental is further shown by the fact that the curvilinear motion which should have been the answer in the present example had Professor Dent's equation been correct, requires two coördinates for its determination. That is to say, Equations [2b] and [3b] should have contained not only the coördinate S but also another coördinate.

Mathematical Difficulties. Professor Dent substitutes $\theta = 90$ deg. in his differential Equations [3] and [5], which he is at liberty to do provided that he draws from it the right consequences. θ is a variable, a function of the time as all other variables and derivatives in [3] and [5] are. Now $\theta = 90$ deg. means nothing else but that the value of this variable becomes 90 deg. at a certain time, say, t. But upon the substitution of $\theta = 90$ deg. all of the variables and derivatives *cease to be variables and derivatives,* but become the values of them for the same t which makes $\theta = 90$ deg. For example, if at the critical speed $\theta = 90$ deg., then at the same time the angular velocity ω of the disk is equal to the critical speed ω_s, that is, a constant and no longer a variable. After the substitution of $\theta = 90$ deg. in Equations [3] and [5] they are no longer differential equations and cannot be dealt with as Professor Dent deals with them in the paper and its three appendices. Further, in order to arrive at his Equations [12] and [13], Professor Dent conveniently drops some of his derivatives because of his claim that their coefficients (which, by the way, are functions of the time) are small. But the value of a derivative may be anything between zero and infinity, and therefore the smallness of a coefficient alone is by no means a sufficient argument for the dropping of a derivative.

F. Hymans.[1]

Yonkers, N. Y.

[1] M. & E. E., Otis Elevator Co. Mem. A.S.M.E.

Unethical Use of Manufacturer's Drawings

To the Editor:

In recent issues of Mechanical Engineering there has been some discussion in regard to the unethical use of blueprints. I am rather of the opinion that the result of this will be a tendency toward preventing blueprints from leaving the shop.

In early days, before we got the idea of service to our fellow-man, whenever a person made a mathematical or scientific discovery, the whole idea was to keep it as a secret for the use of a small group comprising a secret order. The consequence was, naturally, a slow intellectual development.

The present ethical standard of the scientist is to make discoveries for the advancement of civilization. Engineering is applied science, and machine design of the present day is probably more the result of an evolutionary process than any other line of endeavor. Any person who sets out to design a piece of machinery, with any prospect of success, will endeavor to make use of the accumulated knowledge handed down to the present time. This knowledge is largely the result of the costly experience, not of one person but of innumerable individuals and corporations.

Some few companies realize that whenever one of their blueprints goes into a place where it would not ordinarily be seen, it is a source of advertisement and may bring their product favorably before some future purchaser. Professor Sweet's sign, "Visitors always welcome," was an appreciation of this fact. Undoubtedly blueprints have been a slight source of piracy in design, but this is insignificant as compared to the real methods of piracy. Cases are rare, if they ever occur, where a competitor can make use of blueprints, where the same information cannot be procured equally as well from the product itself.

A real source of piracy is the method employed by some concerns in sending one of their men into the shops of a competitor to study his manufacturing methods. Probably the most important cases of piracy are those where some revolutionary invention or idea has either been stolen outright or else purchased for a small fraction of its real value. An attempt to safeguard one's products by withholding blueprints would be about as effectual as the protection of a nation by isolation. Probably in some rare cases blueprints have been put to a wrong use, but the information they contain would have been obtained from some other source. I am a firm believer in the "Visitors welcome" policy, together with the furnishing of blueprints except in rare cases.

Chas. H. Paxton.[1]

Los Angeles, Cal.

The Earnings of Engineers

To the Editor:

Referring to the letter signed by Mr. H. M. Dougherty which appeared on page 380 of the April issue of Mechanical Engineering, I wish to congratulate Mr. Dougherty on his courage in stating the truth; the welfare of the engineering profession needs more men in positions similar to that which the writer of the letter occupies, who have the nerve to state their opinions plainly and boldly, and who have the character to at least try to help those members of their profession who are a step lower on the ladder.

There have appeared recently in various journals articles which should be read by all members of the profession, and not only read, but given serious thought. These articles are:

1 The Engineer: His Due and His Duty in Life, by Thomas Carter, member of the Institution of Electrical Engineers (Great Britain). Inst. E. E. Jl., vol. 64, no. 350, Feb., 1926.

2 The discussion on Mr. Carter's paper in which J. Swinburne, Dr. S. Z. de Ferranti, E. Kilburn Scott, Prof. C. O. Bannister, B. Monat Jones, and many others took part.

3 Compensation of Engineers, by Charles S. Shaughnessy. *Professional Engineer* (A.A.E. Journal), Feb., 1926.

4 In What and Why Does Engineering Education Fail to Attain Its Greatest Possibilities? by Dr. J. A. L. Waddell. *Professional Engineer,* March, 1926.

5 The Engineering Profession and the Public, by Dr. D. B. Steinman. *Professional Engineer,* March, 1926.

[1] Instructor, University of California, Southern Branch. Mem. A.S.M.E.

6 **Engineers**, by Hon. Herbert Hoover, *Engineers and Engineering* (Engineers' Club of Philadelphia), Feb., 1926.

All of the above enumerated articles set forth very plainly the immense responsibility that rests on the engineer, the expense in time and money that he incurs in training himself for the benefit of society, and the sacrifices that he must undergo that the civilized world may live in safety and comfort. That, broadly speaking, the engineer is not adequately recompensed or recognized seems to be generally acknowledged.

Various reasons have been advanced for this condition of affairs, a favorite argument being that the engineer himself is more or less to blame. Stress is laid on the facts (?) that the engineer is not a "business man," a self-seller, a financier, an economist, a good talker, a politician, and on a long list of other shortcomings.

It seems to me that an engineer should first of all be an engineer, and my personal experience is that he is usually a better financier and economist than many who pose openly as such, although I must admit that his efforts are usually not directed toward self-benefit.

I believe that an underlying cause of the lack of recognition of the value of the average engineer is that his services are usually impersonal, that his work requires great mental concentration and a train of thought that the average human being cannot follow, and that while the brain of the engineer is giving birth to material works for the benefit of mankind, the credit for his accomplishments and the financial recognition for such often go elsewhere. Putting the matter crudely, the engineer works and produces after the fashion of the sons of Martha, while the sons of Mary devote their time to benefiting by his efforts.

The unthinking take the stand that the obvious solution is that the engineer should devote time to self-advertising, but a clear insight into the life and work of the engineer reveals that the demands of real engineering are such that time spent in self-advertising is time lost in keeping up with the rapidly growing application of science to the wants of civilization, and that the engineer must devote all of the time he can spare from his daily task to keeping his knowledge up to the mark.

It seems to me that one of the fundamental reasons for the conditions set forth in Mr. Dougherty's letter is that the engineers who are responsible for the employment of subordinate engineers do not insist that such subordinates receive adequate recompense.

Unfortunately, a book is often judged by its cover, and more often a man's value is judged by his income; by the same token an engineer and his work will be judged by the money actually paid for his services.

CHARLES JAY SEIBERT.[1]

Rio de Janeiro, Brazil.

A.S.M.E. Boiler Code Committee Work

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given interpretations of the Committee in Cases Nos. 523 to 525, inclusive, as formulated at the meeting of April 30, 1926, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

[1] Chief Civil Engineer, The Rio de Janeiro Tramway, Light & Power Co., Ltd. Mem. A.S.M.E.

CASE NO. 523

Inquiry: *a* Is it the intent of Par. P-296 of the Code that brass pipe be used to connect the steam gage on water-tube boilers where the steam connection is taken from the top of the water column (which is 20 to 30 ft. from floor) to the steam gage (which is placed about 8 ft. from floor line), or does it apply only to the coil or ball siphon which is attached directly to the steam gage?

b If it does apply to the pipe, then why was no limit of pressure stipulated, as was done in Par. P-321 of the Code?

Reply: *a* Par. P-296 requires that the pipe connections to steam gages, which will include coil and ball siphons, shall be of brass, copper or bronze composition.

b The Code as written places no pressure limitation on piping to steam gages as does Par. P-321 for water-column connections. A revision of the Code in this particular is now under consideration, and until such revision is complete, it is the opinion of the Committee that connections to steam gages should, for pressures over 200 lb., be of steel pipe or tubing, wrought-iron pipe, or of other material capable of safely withstanding the temperatures corresponding to the maximum allowable working pressure. Where steel or iron pipe connections to the coils or ball siphons of gages are used, they should be not less than 1-in. pipe size.

CASE NO. 524

Inquiry: Case No. 522 refers to the counterboring of tube holes on the inner face of the thick-shell drums of high-pressure water-tube boilers. Will it not be equally as practicable to counterbore such tube holes on the outer face of the drum, as shown in Fig. 23,

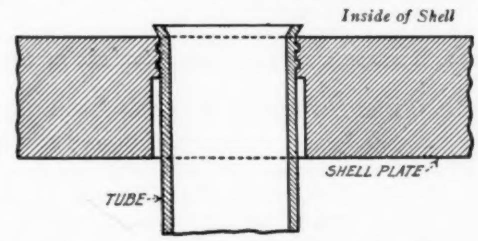

FIG. 23 NARROW TUBE SEAT FORMED BY COUNTERBORING OUTER FACE OF DRUM

so as to form the desired narrow seat into which the tube end can be properly expanded?

Reply: It is the opinion of the Committee that this method of forming the seats for tube ends of water-tube boilers will meet the requirements of Par. P-252 of the Code.

CASE NO. 525

Inquiry: On drums with $2\frac{1}{2}$ in. or more shell thickness, will it be permissible to attach nozzles to the shell with stud bolts tapped into the shell, instead of riveting, using fusion welding to build up a flat surface thereon for counterboring for a raised face joint? It is difficult with riveting on such thicknesses of shell to make a tight joint, even when a double row of rivets is used.

Reply: The requirement in Par. P-268 of the Code that riveted flanges shall be used for nozzles or outlets for all pipe openings over 3-in. pipe size, is impracticable where heavy shells are used at high pressures. It is the opinion of the Committee that until a revision of the Code is made to provide for such conditions, a method of attaching flanged nozzles by studs in place of rivets where sheets are over 2 in. in thickness, may be safely used provided all stresses and materials conform to the requirements of the Code. It is the further opinion of the Committee that, on account of stresses that may be set up in the material of the shell, fusion welding should not be used as proposed in connection with the application of such nozzles.

Revision

PAR. U-82 REVISED:

U-82 When properly welded by the forging process the strength of a joint may be calculated on a maximum unit working stress of S = 8000 [7650] lb. per sq. in. (see Par. U-20).

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

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The Engineer and the English Language

In Mechanical Engineering of last May, Dean Albert W. Smith of Cornell University discussed The Engineer and Liberal Education. His concluding sentence was: "It is time for engineers to stop bewailing the lack of liberal education, and to set about acquiring one." This is like Mark Twain's saying that people talk a lot about the weather but never do anything about it. Many engineers remark frequently that their English needs improvement, but they never seem to set about improving it. Dean Smith recommended that the engineer have a bedside reading table, or a reading chair in a quiet corner, or a collection of the literary classics bound in volumes small enough to slip into the coat pocket. As to a subject for reading, he emphasized that it must hold the interest and not be a forced task; several subjects that he mentioned were mythology, economics, the history of religions, and philosophy. He might have mentioned the history of science, which is perhaps the most appropriate and interesting for an engineer, including as it does the stories of such discoveries as the Copernican theory, or the Arabic numerals, or the laws of mechanics, and such biographies as those of Archimedes, Galileo, Pasteur, and Faraday. Herbert Hoover, it is said, likes to read biography. More than one engineer has developed a taste for Greek science, medieval philosophy, or the social history of the Renaissance. All of these trends are touched upon in the history of science, as also in the history of industrial products such as glass, sugar, and metals.

Improvement in use of the English language is one phase of the acquisition of culture. A famous university president has listed the correct use of one's mother tongue as the first test of an educated man. Perhaps, for an engineer, the attainment of a facility for correct English is the most difficult part of a liberal education. There is no denying that many engineers find the English language a hard problem. This does not mean that the engineer should strive to acquire a "grand style" of ornamental flourishes and pompous verbiage. It means merely that he should avoid grammatical and rhetorical faults of language, and in particular what may be described as professional jargon, and should use English clearly and skilfully, as though he had given as much attention to his language as he had to his shaving and dressing—say, the equivalent of fifteen minutes a day. These fifteen minutes need not be spent in one period, corresponding to the time spent in dressing and shaving in the morning; they should represent a thought now and then throughout the day, on the occasion of his own or some one else's use of English, and a readiness to turn to a dictionary or a handbook of composition.

An engineer who has not had a liberal education at college, need not feel any inferiority complex if his English is poor. He need not think that if he were as lucky as some young collegians of today, his English would necessarily be good and his culture high. Even in those engineering colleges where a generous proportion of cultural courses is included in the curriculum, there are students graduated every year who show little indication of a mastery of English. The reason for this is that an individual's use of English depends in the final analysis upon the care and attention which he gives to it; the tasks or themes that a professor of English sets him to write merely show him the way.

Whatever the system of teaching employed in any particular engineering college, the important truth is that skill in the use of English is acquired by the effort of the individual to improve his writing and speaking. Any student can learn the rules of English from his courses in English provided the instructor is capable; whether the student applies them or not is a matter of his own free will and judgment. Similarly, any engineer who wishes to improve his English can obtain knowledge of the rules from suitable textbooks on the subject. Whether he does this, and whether he applies the rules to his own writing and speaking, depend entirely upon his own initiative and determination. As Dean Smith said in the article cited: "Engineers speak as if the doors of culture were closed to them, whereas they are really wide open." All that is necessary is to get a proper textbook and apply one's self.

If skill in the use of English is so easy to acquire, the question arises, Why do so many individuals today exhibit such a poor command of English? There are several reasons for this. One of them is lack of imagination on the part of students, not only in colleges but also in preparatory schools. Because of this lack of imagination the student does not appreciate the importance of his English courses until it is too late. Such courses appear to him to be less "practical" than courses teaching "hard facts" and the tricks of making a living. The student does not realize that the president and manager of the corporation for which he will later work are likely to be men who achieved their high position not from a "practical" or narrow education but from a liberal background which enables them to understand and influence human nature. So-called "practical" courses are not always the most practical in the end.

The old idea that English should be taught in order to turn the student into a light essayist like Lamb or into a cloudy poet like Browning is passing. The effort in teaching English today is to give the student a command of English such that he can use it skillfully and fluently in his writing and speaking. Incidentally he acquires a general background of culture and learns to read the classics with appreciation of style and of literary effectiveness.

P. B. McDonald.[1]

Welcome to the Cadet Engineers

June has again issued its quota of cadet engineers, enthusiastic in their new knowledge and eager to come to grips with the problems of the world. Older engineers heartily welcome their entry into the ranks of the profession whose achievements have made present-day civilization and whose opportunities are ever broadening in maintaining and improving it.

These newcomers have passed the rigid apprenticeship that an engineering education means. They are prepared to deal with the problems of the world, and in so doing, just as their predecessors did, they will suffer many disillusionments. But among them are the engineering and industrial leaders of twenty and thirty years from now, and in their hands rest the well-being of nations. May their ideals remain unshattered during the intervening years. May they find increasing interest in their engineering work and may they find success and happiness in their lives.

[1] Associate Professor of English, College of Engineering, New York University.

Dr. W. E. Wickenden on the Choice of Engineering as a Profession and Its Possibilities

IN THE issue of the New York *World* of Sunday, May 23, there appeared an interview given by Dr. William E. Wickenden, under the title Getting That First Job, and the Future It Holds. Dr. Wickenden, who is Director of Investigation with the Society for the Promotion of Engineering Education, has carried out careful studies both in Europe and America upon engineering-training methods and the status of men with such training. It will be remembered that at the 1925 Annual Meeting of the A.S.M.E., Dr. Wickenden, then just back from Europe, presented a very interesting paper entitled Education for the Industries of Non-College Type in Europe. In this paper he contrasted European and American conditions.

Paul Sifton, the reporter for the *World*, prefaced his interview with Dr. Wickenden by some rather pertinent remarks. He said:

> The engineer, celebrated by Kipling, Richard Harding Davis, and hundreds of lesser writers, including the authors of correspondence-school advertisements, is, in real life, frequently engaged in hard, routine work, not unusually well paid, and must fight the danger of getting into a rut. He keeps the nation's wheels turning, but the nation hears little about him.
>
> If the engineer is only an engineer, if he does only routine work, drafting plans for and building standard bridges, skyscrapers, highways, electrical plants, bossing a mine, his top salary will probably be from \$5000 to \$7500.
>
> If the engineer is more than an engineer, if he is a business man, a financier, a diplomat and a dreamer, if he can wear corduroys all day and a hard shirt all night, the sky is the limit. He will be paid large fees to go to the ends of the earth, to estimate the possibilities of gigantic projects, to draft plans for putting them into operation. Billion-dollar corporations will ask his advice at his own price; governments will call upon him in times of emergency; the great of the world will listen to him because he knows.
>
> Herbert Hoover, Secretary of Commerce, was a mining engineer; John Hays Hammond was a mining engineer before he was a diplomat and financier.

The picture of the engineering profession drawn by Dr. Wickenden is rather bright as compared to the lately too frequent reviews of a pessimistic nature. In urging careful analysis before launching upon an engineering career, Dr. Wickenden said that mere idle curiosity, mere interest in machinery, mere aptitude for mathematics, the desire to "see the wheels go round" were not ample reasons for choosing engineering as a life work.

Continuing along this same line of thought, he said that the real engineer was not the man who wanted to know what made things work, but the man who wished to analyze each operation and to find out the exact relations between all the parts—he wanted to know how and why things worked and the conditions under which they worked. Altogether too many boys were given an impetus toward engineering because of a purely qualitative curiosity. They had but little analytical ability and interest.

As to the relation of the engineer to society, Dr. Wickenden said that he was the "key" man. Without him the more crowded countries like England, Belgium, Italy, and Germany could not support their inhabitants better than China. Without him there could be no city life with its dependence on transportation, sanitation, and the services of the public utilities. Without the engineer industry would be primitive, local, and on a small scale. Commercial life would be confined to small areas instead of being nation-wide and world-wide. The engineer was concerned with the control of the forces, materials, and energy provided by nature so as to make the world habitable for large populations, so as to increase production per man and per dollar, to get rid of waste, and to make the most of natural resources without which the world would become a wilderness.

Regarding the prospects for young men in the engineering field, Dr. Wickenden said that industry was far below the saturation point and could therefore absorb many more technically trained men. However, more than half the positions were traditionally unattractive to graduates of engineering colleges. While in general the supply and demand in the realm of the strictly technical services appeared to be about balanced, there was a very large unoccupied field in administrative work in industry.

It appeared to Dr. Wickenden that more of the executive responsibility in large industrial corporations was devolving upon men with engineering training. Men with a natural capacity for leadership would find unlimited opportunities for leadership in this field. He also saw a growing influence of the engineering mind in public affairs and cited Mark Sullivan's book Our Times as an economic-industrial approach to history.

Engineering Foundation Makes Important Announcements at Regular Meeting

EDWARD DEAN ADAMS was the guest of honor at a dinner tendered to him by the Engineering Foundation at the Union League Club on May 19, at which were present former members of the Foundation, trustees of the United Engineering Society, and the officers and directors of the four national engineering societies, numbering in all forty-eight persons. Following the dinner the regular business meeting was held, at which L. B. Stillwell, chairman of the Engineering Foundation, presided.

A gift of \$100,000 by Mr. Adams to the Engineering Foundation and the Engineering Societies Library was announced by W. L. Saunders, president of the United Engineering Society and chairman of its endowment committee. This is a material increase in the fund of the Foundation, originally endowed by Ambrose Swasey. Mr. Adams was elected honorary life member of the Foundation in appreciation of his service as vice-president for ten years, and delivered an address on America and Americans. The only other honorary member of the Foundation is its founder, Ambrose Swasey.

It was decided at this meeting to grant financial assistance to two important engineering research projects. Prof. R. S. McCaffery, head of the department of metallurgy, University of Wisconsin, who spoke on Research in Iron Blast-Furnace Slags will continue a study of this subject, undertaken to determine the quality of different iron blast-furnace slags as desulphurizing agents and the possibility of using in the blast-furnace materials of higher sulphur content than is now usual. The outcome of these studies may extend the range of ores and cokes available for blast-furnace work where a low-sulphur product is necessary. The sum of \$10,000 yearly for three years is to be provided by the Foundation, of which \$4000 will be contributed from its own funds and \$6000 is to be raised from the industries interested.

A research in dielectric absorption is to be conducted by Prof. J. B. Whitehead, of Johns Jopkins University. This subject was recommended by the committee on electrical insulation of the National Research Council. It is hoped to extend the knowledge of the nature and origin of dielectric absorption in a way that will be useful to engineers and the electrical industry, and that will add to fundamental knowledge of the subject. In aid of this research a grant of \$5000 yearly for two years was made.

Dr. John A. Mathews, vice-president of the Crucible Steel Co. of America, addressed the meeting, laying stress on the importance of research and giving expression to serious question concerning the extensive standardization that is now in progress. Dr. Mathews' address will be published in full in the August issue of Mechanical Engineering.

Mr. Saunders announced that in response to repeated suggestions from the Founder Societies and to a request from the Engineering Foundation, the United Engineering Society had appointed an endowment committee to seek increase of funds for the Engineering Foundation and the Engineering Societies Library that their financial resources may be enlarged as their opportunities for service develop. The personnel of this committee consists of the following nominees of the four societies and other members:

Ex Officiis:

W. L. Saunders, President, United Engineering Society, *Chairman*
L. B. Stillwell, Chairman, Engineering Foundation
Sydney H. Ball, Chairman, Library Board

Nominees of American Society of Civil Engineers:

Charles F. Loweth, Chicago, Chief Engineer, Chicago, Milwaukee & St. Paul Railway
H. deB. Parsons, New York, Consulting Engineer
Ralph J. Reed, Los Angeles, Chief Engr., Union Oil Company

Nominees of American Institute of Mining and Metallurgical Engineers:

D. W. Brunton, Denver, Chairman, Board of Consulting Engineers, Moffat Tunnel

J. V. N. Dorr, President, The Dorr Company (metallurgical, chemical and sanitary process equipment), New York

Thomas Robins, New York, President, Robins Conveying Belt Co., member Naval Consulting Board

Nominees of American Society of Mechanical Engineers:

J. W. Lieb, New York, Vice-President and General Manager, The New York Edison Company

Wynne Meredith, San Francisco, member of firm of Sanderson & Porter

E. A. Simmons, New York, President, Simmons-Boardman Publishing Company

Nominees of American Institute of Electrical Engineers:

Calvert Townley, New York, Assistant to President, Westinghouse Electric & Manufacturing Company

H. A. Lardner, Vice-President, J. G. White Engineering Corporation, New York

E. Wilbur Rice, Jr., Schenectady, Honorary Chairman, General Electric Company

Members-at-Large:

Charles F. Rand, New York, Past-President, American Institute of Mining and Metallurgical Engineers

James H. Perkins, New York, President, The Farmers' Loan and Trust Company, financial adviser and custodian of securities for United Engineering Society

H. Hobart Porter, New York, of Sanderson & Porter, and President, A merican Water Works & Electric Company

The financial statement of the Foundation from January 1 to April 30 of the current year showed disbursements of $7884.57 and resources of $41,555.21 on hand on the latter date. Of the disbursements $2607.07 was devoted to research projects, and $5208.50 to the promotion and administration of research.

The Sesquicentennial Exposition

On Memorial Day, May 31, the preliminary opening of the long-heralded Sesquicentennial International Exposition took place. This second "World's Fair" at Philadelphia is officially termed "a national thanksgiving for a century and a half of freedom."

Following an imposing parade, air maneuvers, and a salute of 151 guns, the opening addresses were delivered in the Municipal Stadium by Secretary of Commerce Herbert C. Hoover and Secretary of State Frank B. Kellogg. At the same time a cordial message from President Coolidge was read.

While the grounds and buildings will not be entirely complete until the formal opening scheduled for July 4, much of interest can already be seen and a clear idea of the extent of the project obtained.

The Palace of Machinery, Transportation, Mines and Metallurgy, which will be of particular interest to mechanical engineers, is the largest of the many huge structures. This will cover 11$^1/_2$ acres and will house interesting exhibits from the leading centers of the United States and the other industrial nations. Another point of engineering interest will be the League Island Navy Yard, which lies adjacent to the exposition grounds and which, during the event, will be thrown open to the visitors. Beside the historic frigate *Constellation*, veteran of the War of 1812, the monitor *Cheyenne* of the Civil War period, and the *Olympia*, Admiral Dewey's flagship at Manila, will be ranged some of the powerful warships of today. This navy yard contains the largest airplane factory in the world.

Not only is the Exposition interesting from the standpoint of its exhibits, but also on account of its construction methods. The transition from the bare fields to the vast buildings and the landscape layout has been carried out with almost unbelievable speed. This has been made possible only by the intensive use of the latest excavating machinery, materials-handling equipment, and structural methods. To the impressiveness of the completed whole, engineering will also contribute such vital things as lighting effects and sound amplification. To one inclined to look beneath the surface, this more or less hidden "machinery" of the Exposition will be fully as interesting to contemplate as are the exhibits.

In these days when "wonders" no longer enjoy the traditional seven days' duration, it is doubtful whether any sort of a "World's Fair" could arouse the interest and have the widespread influence of the famous Centennial at Philadelphia in 1876. While this antedated the founding of The American Society of Mechanical Engineers by four years, some of the founders and early members of the Society were active in it, and several famous inventions and engineering projects gained their initial impetus from it. It may almost be said that it marked the beginning of the epoch of engineering supremacy, while the present Exposition will mark one of the milestones in this epoch.

Gear Manufacturers Meet in Detroit

In his opening address at the annual meeting of the Association held in Detroit, May 13 to 15, the president of the Association, E. J. Frost (Mem. A.S.M.E.), devoted his attention mainly to the question of industrial relationships. In this connection he stated that his observations had led him to believe that the men of the gear industry were above the average in their attitude toward labor. He recommended the membership to study carefully expansion so as to buy when prices were the lowest, and more than all else, to have equipment all set and ready to go when the wave of improved conditions came. Competition was keen and there was no evidence that there would be any abatement.

In an address entitled, Are You Using Prewar Stuff? Mason Britton, vice-president of the McGraw-Hill Publishing Co., said that every machine had two lives—an economic life and a physical life—and the question was what the relation between the two was, if any, and how quickly a machine tool should pay for itself and be ready to be scrapped.

Recognizing the importance of this matter of machine replacements, Mr. Britton said, the *American Machinist* had investigated the practice of a score of nationally known manufacturers—their principles of machine replacement and their procedure in maintaining the shop at the highest efficiency. These manufacturers agreed on one fundamental thing: the primary thing in keeping shop equipment up to date was to know exactly what each machine was producing and costing. Most of them maintained a complete card catalog of every machine on the job, showing date of purchase, price, work it had been on, hours per week, transference to new work if any, and a list of all repair costs from the beginning. At the General Electric Company's plant in Schenectady there was a force of machine-tool inspectors constantly watching the machine tools. Each inspector's job was to see that the machines under him were getting oil at the right time, that small breakdowns were repaired at once, and that the machines were taken out of service for overhauling whenever necessary; also to spot the machines that were not producing 100 per cent and to recommend that they be transferred, sold, or sent to the scrap heap.

There were two ways to handle machines, Mr. Britton said, one being to run the machine as hard as possible in the expectation that it would pay for itself the quickest. This policy was explained in this way: Any machine tool had so much work in it, and it could all be gotten out in five or six years, or it could be spun along to fifteen or twenty years. But overhead went on all the time whether the machine was working at three-fourths of its rated capacity or at 125 per cent of it. Machine designers were working night and day to beat that machine's accuracy and output, so why not cram the work through hard, get all that could be gotten out of it, and keep the proportion of productive output to overhead as high as possible? The International Harvester Co. was for crowding to a reasonable maximum because of the rapidity with which machinery becomes obsolete, and named two years as a favored time in which a machine should pay for itself. The Corona Typewriter Co. and the SKF industries also named two years. Other companies preferred to handle their machine tools more carefully. The first policy was represented primarily at the automotive shops, while at the other extreme were the railroad shops.

The subject of infections from cutting oils was discussed by W. D. Price, Service Director of the Warner Gear Co., Muncie, Ind., which company has developed a preparation that will destroy germs in cutting oil. This preparation is said to contain tar acid in liquid soap.

S. Timoshenko (Mem. A.S.M.E.) and R. V. Baud, research engineers of the Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa., presented a paper on Gear-Tooth Stresses. By using the photo-elastic method they had studied the stress concentration at the

tooth root, and had established the factors of stress concentration for various radii of the fillet. By using the Herz theory, the local stresses at the surfaces of contact of two teeth in mesh had been examined, and it had been shown that the most unfavorable conditions took place at some depth beneath the surface of contact. Equations for calculating the deflection of teeth were given by the authors, and it was shown that this deflection was usually less than the inaccuracies in commercial gears.

Prof. Earle Buckingham (Mem. A.S.M.E.), of the Massachusetts Institute of Technology, Cambridge, Mass., read a paper on Wear on Gear Teeth. This paper is abstracted on p. 798 of the June issue of *Machinery*. At the annual dinner of the association, Wm. B. Stout, president of the Stout Metal Airplane Co., made the principal address, dealing with the development of transportation, its influence on civilization, and the new era ushered in by the coming of air transportation.

A more complete account of the meeting will be found in *Machinery*, vol. 32, no. 10, June, 1926, pp. 783–784.

Technical Papers at S.A.E. Summer Meeting

A SERIES of interesting technical papers were presented at the summer meeting of the Society of Automotive Engineers, June 1 to 4, at French Lick Springs, Indiana. Some of these were of interest to automotive engineers exclusively, and will be referred to by title only at the end of this report. Others were of more or less general mechanical interest.

The Causes of Wear and Corrosion in Engines were discussed by O. M. Burkhardt, who was of the opinion that lubricating oil in this connection was of controlling interest. To throw away oil as was frequently recommended after 500 miles running of an automobile, he said, would involve an enormous waste.

The Society of Automotive Engineers undertook early in 1925 to organize some researches on contaminated crankcase oil. For this reason arrangements were made early in 1925 with eight car and truck manufacturers that each of them would select six or eight service stations located in cities that best represented the various atmospheric and geographical conditions of the country. Localities from which complaints of engine depreciation were known to have come to many, if not all, manufacturers were included. These carefully selected service stations were then approached with the request to coöperate in the collection of samples of contaminated crankcase oil.

In the analysis of the oil samples all the iron was reduced to iron oxide. This procedure made it necessary to study certain axiomatic relations to one another of the various ingredients found in the ash. Some of these relations were: (1) Wear is a function of the silica, the viscosity, the amount of abraded metal particles, and the number of starts. Starting frequently involves rubbing of dry and partly corroded surfaces. (2) Corrosion is a function of water, of the sulphur content of the fuel, and of the intermittent running and of time.

In a paper entitled Volatility of Automobile Fuels, T. S. Sligh, Jr., presented a brief statement of some fundamental principles relating to evaporation of mixtures and discussed briefly the previous work on fuel volatility. A dynamic volatility method which involved measurements of the percentage of the fuel which was evaporated under equilibrium conditions in some definite mixture of air and fuel was described, and the theoretical aspects of such measurements discussed. Data were presented for a limited number of fuels showing the general characteristics of this type of distillation as contrasted with the Engler. The effect of variations in compositions as affecting starting volatility and operating volatility were shown.

The test described appears to be reproducible, reasonably simple, and to afford a rational rating of fuels as regards starting and operation by observation of the percentage evaporated: (*a*) at low temperatures in a low fuel-air ratio (2:1 or 4:1) with a small percentage vaporized, for starting; and (*b*) at higher temperatures in a normal air-fuel ratio (12:1 to 15:1), with practically complete vaporization, as a measure of operating volatility.

An important subject, The Influence of Temperature, Fuel, and Lubricant in Forming Engine Carbon Deposits, was discussed by three authors (W. A. Gruse, C. J. Livingstone, and S. P. Marley). Among other things, it was stated, it had been found that there was a definite tendency to diminution of deposit as the temperature reached the higher values. It had also been observed that at relatively lean mixture ratios, the influence of changes in the nature of the fuel was small, though real. At a richer mixture ratio a few experiments indicated a greater influence on the part of the fuel. When a less volatile fuel was used there was a sharp increase in the amount of deposit. Within certain limits the amount of deposit increased as oils of increasing carbon residue value (Conradson) were employed.

Hypoid Gears were described in a paper by Arthur L. Stewart and Ernest Wildhaber (Mem. A.S.M.E.). These were tapered gears with offset axes. In general, they looked like spiral bevel gears, which they would in many cases replace. The tooth action of hypoid gears combined the rolling action of spiral bevel gears with a percentage of endwise sliding. The chief advantages of hypoid gears were noiseless operation, increased load-carrying capacity, the possibility of high reduction and low numbers of teeth, long life, and high efficiency. First efforts had been devoted to simplifying the design of the axle as a whole, to studying the problem of getting lubricant to the bearings, to heat-treating the parts, and to improving the materials of construction.

Hypoid gears had always presented great difficulties, both in design and production. Up to the present time, no gears of this type with mathematically correct forms of teeth adapted for successful commercial production had been known.

In a new development, the Gleason Works presented hypoid gears having an accurate and practical tooth shape, and permitting production at no higher cost than spiral bevel gears. The gears might be cut like spiral bevel gears on the existing generators, while the pinions were cut on generators of the same general design, with added adjustment features.

Moreover, the newly developed method of cutting was much more flexible than had heretofore been attained. Even the transverse tooth profiles might be modified at will to any extent. They might be curved so as to bear on the whole depth, while transmitting uniform motion, or they might be modified so as to bear only on part of their depth.

These new hypoid gears, the authors said, had been tested extensively in rear axles under very severe conditions and had successfully carried overloads while continuing to operate with an unusual degree of quietness.

L. R. Buckendale outlined the progress made in the development of automotive worm gearing. In 1917 and 1918 study of the mathematical analysis of the principles of tooth contact and angular velocity brought new designs in tooth forms, which he discussed. The salient advantages of the worm drive were said to be (*a*) silence, (*b*) the fact that it retained its silence throughout its life, (*c*) its ability to resist shock loads without damage, and (*d*) its contours, which might be generated with a grinding wheel after all the other operations had been performed; consequently a high degree of accuracy in tooth profile, lead angle, and tooth spacing might be maintained. Freedom from knock was attributed to the obliquity of approach of the teeth, to the greater areas in contact, and to the low resonant qualities of the materials used.

An indicator described by H. M. Jacklin was claimed to be capable of giving composite indicator diagrams depicting power, offset, and lower-loop effects on high-speed multi-cylinder internal-combustion engines. Briefly, a standard slow-speed indicator having a drum $1^1/_2$ in. in diameter was coupled directly by a standard union to the part of the device that had inside it a small poppet valve which was opened for a very small interval of each cycle of the engine and which, when opened, completed communication between the manifold of the engine and the indicator. The indicator cylinder was filled with heavy lubricating oil to provide a proper seal for the indicator piston and to minimize gas transfer to or from the engine cylinder during each engine cycle.

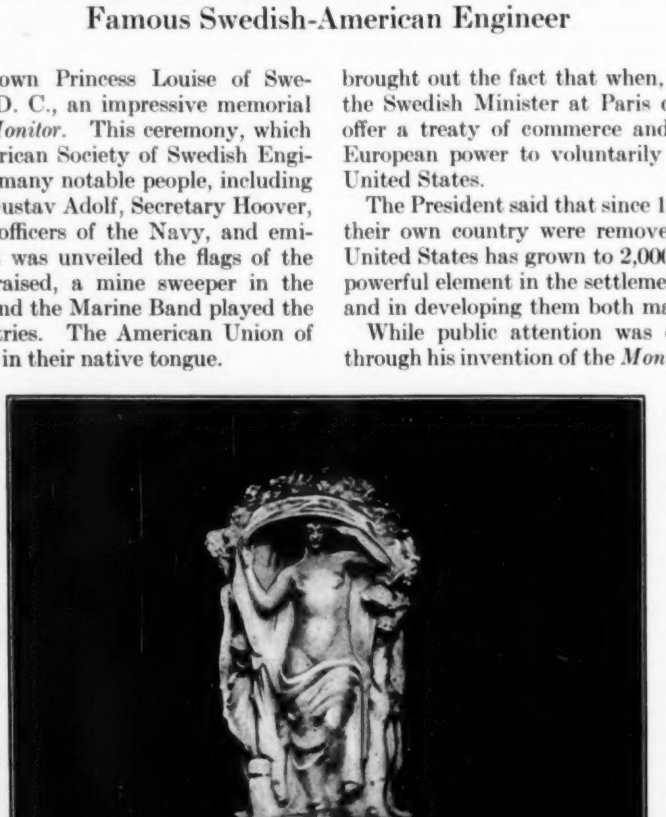
The following papers were also presented: Cushion Springs and Riding Qualities, Walter C. Keys; Instrumentation and Results of Riding-Qualities Tests, Roy W. Brown; Complementary-Color Headlighting, K. D. Chambers; Anti-Freeze Solutions and Compounds, H. K. Cummings; General Results of the Coöperative Motor Truck Impact Tests, Jas. A. Buchanan and J. W. Reid; Balloon Tires for Drop-Center Rims, B. J. Lemon.

Memorial to John Ericsson is Unveiled in Washington

President Coolidge and Crown Prince Gustav Adolf of Sweden Join in Paying Tribute to Famous Swedish-American Engineer

ON Saturday, May 29, the Crown Princess Louise of Sweden unveiled in Washington, D. C., an impressive memorial to John Ericsson, inventor of the *Monitor*. This ceremony, which was under the auspices of the American Society of Swedish Engineers, took place in the presence of many notable people, including President Coolidge, Crown Prince Gustav Adolf, Secretary Hoover, the Swedish Ambassador, ranking officers of the Navy, and eminent engineers. As the monument was unveiled the flags of the United States and Sweden were raised, a mine sweeper in the Potomac fired the national salute, and the Marine Band played the national anthems of the two countries. The American Union of Swedish Singers sang several hymns in their native tongue.

The Ericsson monument is located on the Mall nea rthe Lincoln Memorial and is a striking and dignified creation of the sculptor James Earle Frazier. It is of granite and consists of a massive square pedestal in front of which is a statue of Ericsson and on top of which stands a symbolic group. The inventor is shown seated in a chair in a contemplative mood. The symbolic group consists of three standing figures of heroic size representing Vision, Adventure, and Labor. Delays in the progress of the work had made it impossible to complete the monument by the date of the unveiling. The deficiencies were made up, however, by carefully executed model parts, which gave the work the appearance of completeness.



THE JOHN ERICSSON MEMORIAL

The principal addresses were delivered by the Crown Prince and by President Coolidge. Prince Gustav Adolf voiced the pride which his people took in the fact that in the shadow of the Washington Monument and of the Lincoln Memorial there now stands this impressive monument to a son of Sweden who did so much to preserve the integrity of his adopted country. The Crown Prince said, among his closing words, "To us Swedes this celebration of John Ericsson's memory is expressive of something more significant than his great contributions to modern science. John Ericsson is the incarnation of our desires and hopes for an unbroken friendship with America."

President Coolidge's address was in the main of a historical nature. This not only touched upon the life and work of Ericsson himself but reached back to the history of his home land and of Sweden's part in the upbuilding of America. "Great men," said the President, "are the product of a great people. They are the result of many generations of effort, toil, and discipline. They do not stand by themselves; they are more than an individual. They are the incarnation of the spirit of the people." The President mentioned the Swedish Colony founded in Delaware in 1638, John Morton, the Swedish signer of the Declaration of Independence, the fourteen or more Swedish officers who served the Colonial cause in the Revolutionary War, and John Hanson of Maryland, who, in 1781, was the first man to hold the title of "President of the United States in Congress Assembled," and who later installed George Washington as the first President. These, and many others, were the historic ties between this country and Sweden. He also brought out the fact that when, upon the close of the Revolution, the Swedish Minister at Paris called upon Benjamin Franklin to offer a treaty of commerce and amity, Sweden became the first European power to voluntarily express its friendship toward the United States.

The President said that since 1843, when restrictions upon leaving their own country were removed, the Swedish population of the United States has grown to 2,000,000. This has been an especially powerful element in the settlement of the great northwestern states and in developing them both materially and culturally.

While public attention was concentrated upon John Ericsson through his invention of the *Monitor* during the first year of the Civil War, the engineering work of this remarkable man covered a long period both before and after that time. He was born on July 31, 1803, at Filipstad in the province of Varmland, Sweden. His father was a mining operator in a small way and the boy Ericsson gained his first mechanical experience in watching the primitive pumps and hoisting machinery.

When the mining project proved unprofitable the father became a foreman upon construction work of the Göta Canal, and the family removed to the village of Forsvik in northern Sweden. There were many Englishmen on this project who had been trained by the famous canal builder Telford. From these men John Ericsson at an early age learned much about drafting, mathematics, chemistry, surveying, and also the English language.

At fourteen young Ericsson was actually given charge of important work on the canal and had under his charge a large force of laborers. After three years of this work he entered the Swedish army, serving as an ensign in a rifle corps. He became expert in the designing of heavy ordnance and was soon raised to the rank of captain.

Ericsson went to Havre at the age of twenty-one, where at the shipyard of M. Mazeline he became deeply interested in the subject of the screw propeller, one which had an important bearing upon his later work. In 1826 he went to England where he became assistant, and later partner, of John Braithwaite, a noted engineer and manufacturer in London. Ericsson then applied compressed air for power purposes in the tin mines of Cornwall, devised the forced draft by centrifugal blowers to boiler furnaces, perfected a surface condenser, and designed a successful fire engine. One of his crowning achievements in England was his locomotive *Novelty*, which made a remarkable showing in competition with Stephenson's *Rocket* at Rainhill in October, 1829.

One of Ericsson's few close friends in England was Francis B. Ogden, United States Consul at Liverpool. This led to a meeting with Lieut. Robert F. Stockton of the United States Navy. Lieutenant Stockton became keenly interested in Ericsson's screw propeller and improved marine engines, and gave him an order for two iron steamers for the Navy, so equipped. Encouraged by this Ericsson, in 1839, went to the United States with complete plans for a steam frigate. After much opposition these plans matured in the 600-ton *Princeton*.

From that time until the outbreak of the Civil War Ericsson worked feverishly upon the development of the "caloric" or hot-air engine, of which he had his original conception in Sweden as early as 1819. His achievements in this direction were brilliant but never came up to his expectations, because he greatly overestimated the power possibilities of air.

When the Confederate Government raised the hulk of the old *Merrimac* and converted it into the formidable ironclad ram *Virginia*, there was consternation in the North. It was then that Ericsson came forward with his plan of the "cheese box on a raft," as his low-lying craft with the revolving turret was christened by skeptics. When, on March 9, 1862, this hastily built *Monitor* successfully engaged the hitherto triumphant Confederate ironclad in Hampton Roads, a great chapter was written in history and Ericsson's name became immortal.

For twenty-seven years following this memorable event, generally called the "Battle Between the *Monitor* and the *Merrimac*," John Ericsson lived quietly in the city of New York. In spite of his eighty-six years he retained almost to the last his unusual vigor of body and mind, and worked unremittingly upon important inventions and engineering problems. He was associated with Cornelius H. Delameter in the famous Delameter Iron Works.

John Ericsson became a member of The American Society of Mechanical Engineers in 1881, and in 1883 was nominated for vice-president of the Society. This honor he regretfully declined because, as he wrote, "...other duties of various kinds do not admit of my leaving my office at any time, I might say day or night, since the work before me demands far more time than I have left."

In view of these facts it was particularly fitting that the A.S.M.E. was among the many engineering bodies represented at the unveiling of the memorial in Washington. Those representing the Society at the ceremony were John Ericsson, City Engineer, City of Chicago, and Erik Oberg, Treasurer of the A.S.M.E.

John Ericsson died on March 8, 1889, and was buried at Filipstad, Sweden. President Coolidge expressed a fine sentiment when he said, "He sleeps among the mountains he had loved so well as a boy, but his memory abides here."

Patent Office Committee Submits Recommendations

Outstanding Needs Include a New Modern Building and Equipment, an Increased Technical Force, and Amendment of Existing Law to Facilitate Handling of Appeals

A new modern building suitably constructed and equipped, an increased technical force with adequate salaries, and amendment of existing patent law to facilitate the handling of appeals are among the outstanding needs of the United States Patent Office if it is to render the timely service that American business demands, Secretary Hoover has been advised by the Special Patent Office Committee.

This Committee, originally appointed by Secretary Work of the Interior Department in July, 1924, was enlarged by the addition of two engineers nominated by The American Society of Mechanical Engineers at the time the Patent Office was transferred to the Commerce Department in April, 1925.

Since making a preliminary statement to Secretary Work in February, 1925, the Committee has completed its full report which goes into all phases of Patent Office activity, containing one hundred and eight separate recommendations which are summarized in part below.

Improved quality of work and increased productivity, the report states, are the demands being made upon the Patent Office. Of these two factors, quality is the more fundamental and necessary. Unless the quality of the work done by the Patent Office is reasonably thorough and authoritative, the very fiber of the Patent system is threatened. Therefore, quality is the central theme of the report. However, quantity of production has not been neglected. Neither the quality nor the quantity demanded and required to meet present-day needs can be realized until a number of fundamental changes are made. What these changes should be are encompassed in the recommendations contained in the report.

Summary of Committee's Recommendations

Administration. Divide administrative and judicial functions, assigning the latter to Assistant Commissioners. Create position of Administrative Assistant to Commissioner, whose duties shall be to supervise all financial and clerical operation; supply necessary aid to technical divisions; assign and transfer examiners; promote improved and uniform standards of work in office; organize classification, and translation, digest, filing, stenographic and messenger services; and supervise building management and personnel relations.

Building and Equipment. Request Congress to appropriate immediately an amount sufficient to provide for the present and future housing and equipment needs of the Bureau of Patents.

Classification of Patents. Increase personnel of Classification Division in order that it may (*a*) immediately revise the 56 unrevised classes; (*b*) revise classes established since 1898 that have been obsolete; (*c*) resume cross-referencing of patents; (*d*) complete numerical index of patents; (*e*) classify foreign patents as received, and all foreign patents now in Patent Office; (*f*) organize a service for the digesting and indexing of technical literature; Provide Division with vertical filing cases.

Claims. Encourage practice of restricting number of claims in applications, and increase filing fee by $1 for each claim in excess of twenty.

Clerical Divisions. Thirty-three recommendations dealing with simplifications and improvements in carrying on clerical work of the office, supplying printed copies of patents, etc.

Examining Divisions. Increase entrance salary of Examiners to $2400 per annum, and raise classification of present staff so that Examiners shall receive from $2400 to $5000, Principal Examiners $5200 to $6000, Assistant Commissioners, $6000 to $7500, and the Commissioner $10,000. Organize a force of 20 translators to brief in English all foreign language patents immediately on receipt; also those now on file in the Patent Office. Organize a service to translate and digest material from foreign technical books and periodicals for benefit of all interested divisions. Establish a sufficient permanent force of expert file clerks, and standardize on steel vertical files, counter height, and 9 in. wide.

Retain the 100 temporary examiners recently authorized by Congress until work of Office is up to date and quality satisfactory, and add 60 permanent examiners to technical force to classify U. S. patents (30), foreign patents (5), and technical literature (5), and to brief foreign patents and literature (20).

Simplify routine of Trade-Mark Division; change required size for original trade-mark drawings to 8 × 13 in.; institute one form of interference card which will serve for interferences, oppositions, and cancellations.

Financing. Increase filing and final fees $5 each to provide funds necessary to render the increased quantity and quality of work that is essential.

Judicial and Legal. Reduce time for amending to six months and limit period of renewal to one year. Empower Commissioner to require an application that has been pending for three years to be put in condition for final action by the next amendment. Limit time within which applicants may appeal in *ex parte* cases to six months. Abolish appeals in *ex parte* cases from the Patent Office to the Court of Appeals of the District of Columbia.

Permit use of interrogatories in patent as well as in trade-mark interferences for the discovery of facts and documents material to establishing the case of the party propounding such interrogatives. Abolish all direct appeals in interferences from the Patent Office to the Court of Appeals of the District of Columbia, and make decision of Examiner-in-Chief final, subject to the general supervisory power of the Commissioner.

According to officials of the Commerce Department, many of the foregoing recommendations are already in effect. One change made in printing methods will save over $8000 a year. Adoption of photostatic instead of typewritten copies of patent deeds recorded will be in effect by the first of July and should save approximately $10,000 a year. A new index in the Assignment Division is already completed, having been begun before the Committee commenced its duties. It is in daily use and will effect a saving of many times its cost.

A complete study of the report is being made and the recommendations not already adopted will be put into effect as rapidly as possible. Many of them cannot become effective until appropriations are increased and other legislative authority obtained.

Complimenting the Commissioner of Patents for his "successful

handling of an unprecedented amount of work," the Committee said:

The Committee takes pleasure in commending the present administration of the Patent Office for the good work already done. It has succeeded in materially reducing the number of pending applications, and at the same time it has made many improvements. The changes in the methods made have been in the right direction and meet with unqualified approval of the Committee. The recommendations in this report are based mainly upon information obtained from the Commissioner and his staff and in a measure represent contemplated action which, for a variety of reasons, they have been unable to undertake. Consequently, this report is offered as an instrument of assistance in furthering the good work already undertaken.

We find that during the administration of Commissioner Robertson many improvements suggested by the 1912 report have been made and also many additional beneficial changes have been effected in the organization, procedure, personnel, and property of the Patent Office, amounting to a thorough reorganization. This has been facilitated by favorable legislation and by additional room obtained in the Land Office Building, but before any legislation was obtained, as well as since, improvement has been noticeable in the methods of doing business in the office, resulting in a marked increase in efficiency and benefit to the public having business before the office.

At the time the Secretary of the Interior first considered the appointment of the Committee the work of the Patent Office was fourteen months behind. For many years its activities had been rapidly increasing while the resignations from its highly trained scientific and technical force have always been distressingly frequent. Recognizing the seriousness of the situation because of the vital importance of the work, the American Bar Association, several Patent Law Associations, the Chamber of Commerce of the United States, the National Manufacturers' Association, and the American Engineering Council were invited to nominate members to serve as a committee to study the Patent Office for the purpose of seeing whether its procedure could be simplified and its business expedited. In addition to the two engineers added to the Committee by Secretary Hoover, it had the assistance of Harold N. Graves of the Commerce Department, Paul Holden of the U. S. Chamber of Commerce, and Captains Morgan and Littlejohn of the Bureau of Efficiency.

"The public spirit displayed by the members of the Committee and their earnest, laborious efforts to solve trying and difficult problems, are deserving of the highest commendation," Secretary Hoover said in acknowledging receipt of the report on behalf of his Department. "This Committee," he said, "was composed of men of wide experience in patent matters and others of similar experience in industrial and commercial affairs. Although busy men and serving without remuneration or hope of personal reward, the members gave generously of their time and made a most exhaustive study of the patent office, and its needs."

The members of the Committee are:

Hon. Thomas Ewing, of New York City, formerly Commissioner of Patents, and nominated by the New York Patent Law Association.

Col. Harry Frease, of Canton, Ohio, formerly president of the Cleveland Patent Law Association, and nominated by that association.

Jo Baily Brown, of Pittsburgh, Pa., one of the patent advisers representing the United States at the Paris Peace Conference, and nominated by the Pittsburgh Patent Law Association.

A. J. Brosseau, of New York City, a prominent automobile manufacturer, nominated by the Chamber of Commerce of the United States.

Henry M. Huxley, of Chicago, Ill., secretary of the Chicago Patent Law Association, and nominated by that association.

Eugene G. Mason, of Washington, D. C., formerly secretary of the patent section of the American Bar Association, probably the largest association of its kind in the world, and nominated by former Secretary of State Hughes, who is president of that association.

George A. Prevost, of Washington, D. C., vice-president of the American Patent Law Association, the national association of patent lawyers, having members in 53 American cities.

Edwin J. Prindle, Mem. A.S.M.E., of New York City, formerly secretary of the Patent Committee of the National Research Council, and nominated by the National Association of Manufacturers.

Milton Tibbetts, of Detroit, Mich., assistant secretary of the Packard Motor Car Company, and formerly president of the Michigan Patent Law Association, and nominated by that association.

L. W. Wallace, Mem. A.S.M.E., of Washington, D. C., executive secretary of the American Engineering Council, consisting of 29 engineering societies representing almost 40,000 engineers.

Henry N. Paul, Philadelphia, Pa., president of the Philadelphia Patent Law Association.

Wallace Clark, Mem. A.S.M.E., industrial engineer, New York City.

W. H. Leffingwell, Assoc. A.S.M.E., president of the Leffingwell-Ream Co., New York City.

Tentative Findings of the A.L.A. Committee on Library Extension

Existing Library Facilities and Use in the United States and Canada

6516 public libraries.

63,244,970 people in their service areas.

$36,614,483 expended for public libraries in a year, or 32 cents per capita for entire population.

67,919,081 volumes in public libraries, or *0.6 volume per capita for entire population.*

234,492,759 volumes issued from them in a year, or 2+ per capita for entire population.

222 counties out of 3065 spending public funds for public-library service.

58 public libraries in the South serve 1,077,251 negroes.

38 state library commissions or other state library-extension agencies in operation, and 3 more authorized (out of 48 possible for the whole country).

2 provinces out of 9 of Canada have regular state library-extension agencies, and 4 more have provincial book service from some agency.

598,925 individual volumes issued in a year by state agencies, by direct mail service or book automobile.

31,174 collections or traveling libraries sent out.

Without Public Library Service

51,254,133 people in the United States and Canada, or 45 per cent of the total population of the two countries, without access to local public libraries.

47,655,688 live in the open country or in places of less than 2500 population.

83 per cent of the rural folk of the United States without local public-library service.

1160 counties without any public libraries in their boundaries.

652 places of from 2500 to 10,000 population without public libraries.

60 places of from 10,000 to 100,000 population without public libraries.

7,718,300 Southern negroes without public-library facilities.

7 states and 7 Canadian provinces without organized state library-extension work.

Stabilization in the Machine-Tool Industry

The spring meeting of the National Machine Tool Builders' Association was held in Providence, R. I., May 6 and 7. Ernest F. DuBrul (Mem. A.S.M.E.), general manager of the Association, made an address stressing the importance of the statistical work which it carries on.

Between industries, as between individuals, said Mr. DuBrul, exchange of information made for more profitable operation. Each year more and more industries were beginning to gather, report, and compare facts. This widespread movement was helping out industry right now. Leading executives of large buyers of machine tools were putting their brains to work on the problems of business stabilization. They were engaging qualified men to study buying, selling, and production policies with that end in view.

As more and more of the large users of machine tools adopted this policy, said Mr. DuBrul, we should see more orders for machine tools placed just when they were wanted most, and of course fewer orders placed just when they were needed least. That would mean a more stabilized market for tools, more stabilized employment and production, more stable costs, and more stable profits. Of course, improvement in these respects was bound to be slow. We should never see the time when all machine-tool buyers would have consulting economists at their elbows, nor when economists could forecast conditions with absolute certainty. So we could never expect to smooth out all the fluctuations in demand. They were too much a part of the very nature of machine-tool demand to hope for their elimination. We could only hope for and work toward a gradual decrease in their violence, and while doing that, we should have to learn to run with the tide that we could not control.

Book Reviews and Library Notes

THE Library is a coöperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E. and the A.I.E.E. It is administered by the United Engineering Society as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references to engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

The Miner's Freedom

THE MINER'S FREEDOM, by Carter Goodrich. Marshall Jones Co., Boston. 189 pp., $2.

THIS is a valuable and instructive presentation of a neglected phase of the coal-mining question, the human end of an engineering problem. The author throws his light into dark places so tactfully and in such a vivid and interesting way that one instinctively broadens and humanizes his viewpoint as he goes along. Here we have presented to us fairly the outstanding need of the industry today: a tolerant understanding of the broadest aspects of the whole subject. Viewed in this light, Professor Goodrich, through the Amherst Fellowship, has made a real contribution to the literature of the industry. Were the writer a mine executive, he would not only read the book but would pass it down through the organization.

NIXON W. ELMER.[1]

Piano-Playing Mechanisms

PIANO PLAYING MECHANISMS, by William Braid White. Edward Lyman Bill, Inc., New York, 1925. Cloth, 5 × 7 in., 240 pp., 52 diagrams. $3.

EVEN a casual reading of this book will impress one with the fact that a remarkable work in engineering has been successfully accomplished by the player-piano manufacturers. The author tells us that "the course of invention and development in this field of musical industry has not been consciously developed along scientific lines." However, in the light of present results it appears that the present-day ordinary player-piano and the "automatics" and the "reproducers" with their host of accessories all operated by slight and varied differences between atmospheric and controlled vacuum pressures, are worthy of the keenest and ablest attention that the scientist and engineer can bestow. Innumerable valves of the flap, disk, and slide or D style, with their low-air-pressure operation and their return action accomplished by means of springs, gravity, or positive motion, together with a large number of lever and crank controls, must all be operated to obtain a *smooth* flow of power which may be instantly modulated to give tone and tempo results, and to give motion to numerous accessories such as occur in the "automatics," the "reproducers" and the "coin-operated" machines. With all this it is to be noted that the source of power, as produced by pedaling, is varied, and that the control of all the operations, particularly in the "automatics," is furnished by the small perforations in the paper music roll in accurate register with the 88 openings in the tracker duct. All this constitutes a problem of fair proportions in delicacy of manufacture and in automatic operating adjustment. Constructions that work well on loud playing may work poorly on soft playing, and devices must be introduced to correct this; a smooth flow of power must come from intermittent power impulses, and a pneumatic "flywheel" must be introduced in the shape of an "equalizer valve;" a heavy valve works sluggishly and an adequate lightweight valve presents a problem in material and wear, so a light valve is made to operate the heavier controlling valve; a "wind motor" must operate the music roll fast or slow, forward or backward, change speeds quickly, and stop instantly, all under a pressure control scarcely heavier than is exerted by drawing in one's breath; one re-roll lever must shift the gears, cut off playing action, and open a special speed valve—all simultaneously; a marginal perforation in the music roll and a corresponding marginal duct must serve to automatically and delicately adjust the entire roll to the tracker ducts; and finally, not only the motion of the hammer but the strength of its blow which must be subject to the will of the player, or to automatic regulation through the perforated music roll, must be mechanically provided for.

The latter part of the book is devoted to descriptions and illustrations that are characteristic of the Ampico, Angelus-Artrio, Artecho, Duo-Art, Welte-Mignon, and Welte (Licensee) reproducing systems; to the coin-operated pianos; and to repair and maintenance.

F. DE R. FURMAN.[1]

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The Flow of Water in Pipes

FLOW OF WATER IN PIPES. By Hiram F. Mills, with Historical and Personal Note by John R. Freeman and Introductory Outline by Karl R. Kennison. Published by the American Academy of Arts, Boston, Mass. Quarto, 236 pp., $7.50.

THIS beautifully printed book presents the results of more than 50 years of study of hydraulic problems by a man of unusual capacity for observation and analysis.

The material relates mainly to the flow of water in pipes, and was intended to be the first part of a complete treatise on hydraulics, but these pages represent all of the work that the author's strength and life permitted.

The studies were made in the first place to find means for accurately measuring the water supplied by the Essex Company, of Lawrence, Mass., to the various mills on its canals for power. The work was afterward greatly extended by Mr. Mills, we may believe, for the pure love of finding the exact truth. We know that for a period of many years the project of a treatise on hydraulics lay dormant while even more important matters occupied his attention.

The statement of experimental methods used in 1875, beginning on page 147, leaves one in doubt which to admire most: the sturdy, simple measures taken to find out the exact truth, or the clear, concise English in which the methods are pictured. These pages bring back to the writer the memory of what he saw at Lawrence during the years when he helped Mr. Mills with other matters. He remembers the numerous observing stations manned by careful, conscientious young men, observing water levels at predetermined intervals, and writing down the results to be plotted and averaged and compared, until everything was checked and accounted for beyond a possible doubt. The writer knows something of the thorough methods of Mr. Mills, for they were also applied to the work which he did at Lawrence. Each of the experimental results stated in the tables is the average of many single tests, and one feels that the results can be depended upon for such strict accuracy as is rarely found in the records of experimental work.

The amount of new experimental material on the flow of water in pipes is very large, and its character is of a high order. It includes the records of flow in small brass pipes made by Mr. Mills himself, and in larger brass pipes by his assistant, Mr. John R. Freeman, extending to pipes as large as 4 in. in diameter, and to velocities as high as 30 ft. per sec. The text gives some idea of the care taken to prevent roughness at the joints and on the interior surfaces, and the coefficients that were obtained, not exceeded by any since obtained, are convincing evidence of the thoroughness with which all roughness and obstruction were avoided.

Other experiments by Freeman on wrought-iron pipes from the smallest commercial sizes up to 8 in. in diameter, and with velocities extending to 13 and in some cases to over 20 ft. per sec., are recorded. Other experiments on wrought-iron pipe, by J. B. Francis, cover a much shorter range of velocities, and there are experiments on cast-iron pipe, new and old, by Mr. Mills, and by several of his assistants and associates.

The experiments upon one line of specially prepared 12-in. cast-iron pipe made during the years from 1875 to 1882 are unique in their thoroughness. No less than 1045 separate determinations are summarized in the tables of results.

To the rich data made available to Mr. Mills, he added the results of published experiments which he believed to have been reliable, and the whole mass of data was then analyzed to determine as far as possible the laws of flow. Many matters are taken up and the business developed to form a complete treatise on the flow of water in pipes.

All the elements of flow are discussed, including size, material, age, and condition, but, from the present standpoint, perhaps the matter of greatest scientific interest to us is the study of the relations between velocity and slope or friction. The experiments available covered a remarkable range from low to high velocities with the greatest accuracy. The method of study was unique and would be only possible with the very best of data. It is carried out in a way that, as far as the writer knows, has never been elsewhere attempted.

Below the critical velocity, the friction increases as the first power of the velocity. This old law Mr. Mills found to almost exactly represent the facts. At high velocities the friction increases nearly as the second power of the velocity, but it is not exactly the second power. It is usually some fractional power materially less than the second power. These small and varying deviations from the second power could not be accepted by Mr. Mills without adequate explanation.

There was much of the mystic in his make-up, and with Swedenborg he regarded water as the material emblem of Truth. No effort was too great to find out exactly what took place, and why.

His description of the flows near the critical velocity as determined by piezometer measurements and otherwise, is one of the most interesting things to be found in this remarkable volume. His study shows that passing upward, as the critical velocity is passed, there is not an abrupt change in the method of flow, but that, instead, there is a gradual introduction of a rolling of the water and a new element of resistance growing out of it not existing at lower velocities, and this new element increases exactly as the square of the velocity, but does not make up the whole of the resistance, for some of the conditions of flow below the critical velocity still continue at higher velocities and are only gradually displaced. Even at full ordinary velocities an appreciable amount of the conditions of the low flows remain, especially with pipes that are quite smooth.

An ingenious mathematical analysis of the record of each pipe separates these elements and shows the amount of each. Charts show graphically how and when the changes come about. There is finally presented a table on page 165 which shows, among other things, how the elements operating at lower velocities and depending upon temperature and viscosity persist in some measure in smooth pipes, and in smaller measure in rough pipes at higher velocities. From all this it is easy to see that what we have long known and expressed roughly by fractional exponents is really based upon deep-seated laws of flow.

In studying the flows near and for some distance above the critical velocity, Mr. Mills has developed two intermediate formulas to cover the transition stage, and, with these, for a given pipe, there are in all four formulas of flow, one for the range below the critical velocity, two for intermediate or transition stages, and the last for higher velocities. It is not to be supposed that these formulas will displace the ordinary short-cut approximate methods in common use, but it is certainly interesting to see how apparently erratic variations near the critical velocity can be explained and are found to be parts of one harmonious system.

The writer remembers that in 1892, as he was making some hydraulic calculations for Mr. Mills, he was given a paper showing how those calculations were to be made. This remained among some old prized papers until long afterward. In 1919 he came across it and was struck anew with the merit of the idea which it represented. He called Mr. Mills' attention to the matter at the time and suggested publication, and received from him a kindly letter in which it was explained that he hoped to publish the whole work some time and that in the meantime he wished to have the matter held confidential. Needless to say the wish of Mr. Mills was respected, but notwithstanding this, it would be difficult to say to what extent the ideas of the writer and perhaps of others have been influenced by Mr. Mills' work, and to what extent his ideas have found expression and extended use, even though the publication was so long delayed.

Our most cordial thanks are due to Mr. Freeman and to Mr. Kennison for making this material available to us, and it is to be hoped that the announced intention of presenting an abstract to the American Society of Civil Engineers, of which Mr. Mills was an honorary member, will be carried out.

Allen Hazen.[1]

Books Received in the Library

Corrosion—Causes and Prevention. By Frank N. Speller. McGraw-Hill Book Co., New York, 1926. Cloth, 6 × 9 in., 621 pp., illus., diagrams, tables, $6.

An important reference work for all who are interested in any of the many phases of the problem of corrosion, combined with a handbook of practical preventive methods of interest to engineers and architects. Part one treats of general principles. After an explanation of the nature and mechanism of corrosion and of the theories advanced to explain it, the author discusses the influence of methods of manufacture and treatment, of composition, and of external factors on corrosion. The principles and methods of tests are then described and a chapter is devoted to the question of the relative corrodibility of the various ferrous metals. Part two discusses measures for preventing corrosion under various service conditions. Corrosion in the air, under water or under ground, corrosion in hot-water systems and in steam plants, and corrosion caused by chemicals or electric currents are discussed at length. Many references to other work are given in the notes and bibliography. Dr. Speller's long study of the subject has enabled him to write a book of great value to all engineers.

Das Deutsche Warenzeichenrecht. By Werner Pinzger and Felix Heinemann. Otto Liebmann, Berlin, 1926. Paper, 6 × 9 in., 492 pp., 18 mk.

This commentary on the German trade-mark law is the work of a counsellor of the Court which deals with trade-mark cases, and of a patent attorney. It contains the text of the current German law, with an extended theoretical and practical commentary on the various provisions of it, together with an appendix on the supplementary regulations of German national law and of international law.

Dies. By Joseph V. Woodworth. Seventh edition. Norman W. Henley. Publishing Co., New York, 1926. Cloth, 6 × 9 in., 426 pp., illus. $3.50.

A compendium of information on dies, press fixtures and devices for working sheet metal, prepared for practical mechanics. The author covers a wide field and illustrates the use of dies for a great variety of work, confining himself to methods in use at present.

Dieselmaschinen. Sonderheft V.D.I. Zeitschrift, 1923. V.D.I. Verlag, Berlin, 1924. Paper, 9 × 12 in., 70 pp., illus., diagrams, tables, 12 × 9 in., paper. 5 g.mk.

A collection of papers on Diesel engines, reproduced from the

[1] Hazen & Whipple, Consulting Hydraulic and Sanitary Engineers, New York, N. Y.

issues of the V.D.I. *Zeitschrift*. Among them are The Diesel Engine of Today, by Dr. Naegel; Fuels and the Combustion in the Diesel Engine, by Dr. Alt; Improving the Efficiency of the Diesel Engine, by Dr. Riehm.

DIE DRAHTSEILBAHNEN. By P. Stephan. Fourth edition. Julius Springer, Berlin, 1926. Cloth, 6 × 9 in., 572 pp., illus., plates, 33 mk.

A detailed descriptive work on aerial ropeways and cableways, and telphers. The book is written from the point of view of the user rather than that of the manufacturer. After a brief historical introduction, the various elements of ropeways (cables, supports, cars, stations, safety devices, etc.), are described. Examples of the use of ropeways as mountain railways and industrial conveyors, in mines, harbors, and mills are then given, after which special types, such as gravity ropeways, single-cable ways, passenger ropeways, and cableways are discussed. Economic and legal matters are then taken up, followed by a chapter on erection and operation. The types described by the author are those now manufactured in Germany.

LES ECONOMIES DE COMBUSTIBLES; COMBUSTIBLES INFÉRIEURS ET DE REPLACEMENT. By Pierre Appell. Paper, 6 × 8 in., 203 pp., illus., tables, 20 fr.

A concise discussion of low-grade fuels and their economic possibilities. The author treats of wood, charcoal, coke, lignite, and peat, and of mine, industrial, and municipal wastes, describing methods of utilizing them and enumerating their possibilities as substitutes for coal and oil.

ETHICS OF BUSINESS. By Edgar L. Heermance. Harper & Bros., New York, 1926. Cloth, 6 × 8 in., 244 pp., $2.

Standards of business conduct, sometimes unwritten, sometimes expressed in definite codes, have been developing during the past quarter-century until today, Mr. Heermance believes, the average American merchant of the better class is probably more ethical than his patrons. In this book he presents these standards and the reasons for them, giving a useful picture of the development of business ethics in the United States. The author also intends his book as an introduction to social ethics, and therefore makes certain generalizations and interpretations of the ethical process in trade associations, as a contribution to ethical theory.

EVAPORATION. By Alfred L. Webre and Clark S. Robinson. Chemical Catalog Co., New York, 1926. (Modern library of chemical engineering.) Cloth, 6 × 9 in., 500 pp., illus., diagrams, $6.

The object of this book is to present modern ideas concerning evaporator design and operation, arranged in a form adapted to the needs of engineers. The volume opens with a consideration of the theoretical factors, followed by practical direction on the operation of evaporators. The applications in various industries, such as the sugar, dye, and paper industries, are then discussed. The concluding section describes the various types. The book contains, the author says, theoretical and practical data accumulated during twenty years of experience.

FLIESSARBEIT—Beiträge zu Ihrer Einführung. Edited by Frank Mäckbach and Otto Kienzle. V.D.I. Verlag, Berlin, 1925. Cloth, 6 × 8 in., 360 pp., illus., plates, 12 r.m.

"Fleissarbeit" is the German name for those modern methods of work, such as the use of continuous conveyors, portable tools, etc., which have so greatly accelerated and cheapened factory operations. The present volume is an attempt to present the fundamental considerations of this method in systematic form and thus aid in their introduction into practice. Twelve authors share in the text.

The first section introduces the subject, explaining the method, giving fundamentals, and discussing general questions. Section two discusses specific questions: planning, production, interchangeability, transportation, foundry methods, machine work, assembling, inspection, cost accounting, etc. The third section is a critical evaluation of the existing literature on the subject.

GETTING OUT THE COAL. Compiled by Frank H. Kneeland. McGraw-Hill Book Co., New York, 1926. (Practical Coal Production.) Cloth, 6 × 8 in., 403 pp., illus., diagrams, tables. $3.

This volume, like the preceding volume on the Preliminaries of Coal Mining by the same author, is essentially a compilation from recent periodical literature. The author has classified and arranged the material in a connected narrative, so that a satisfactory account of current methods is achieved.

GÜTERUMSCHLAG; Die Güterumschlag-Verkehrswoche des V.D.I. in Düsseldorf und Köln, 1925. Sonderaugsgabe der Zeitschrift des V.D.I. V.D.I. Verlag, Berlin, 1926. Paper, 8 × 11 in., 256 pp., illus., diagrams. 30r.mk.

In September, 1925, a week-long conference on the problems of freight traffic was held in Düsseldorf and Cologne under the auspices of the Verein Deutscher Ingenieure. The papers presented appeared in the V.D.I. *Zeitschrift*, and are now collected in the present volume. While questions of railroad freight handling are most extensively treated, there are papers on boat traffic, harbor machinery, street and light railroads, and on motor-truck and airship freight handling. Special attention is given in these papers to loading and unloading machinery and to the efficient utilization of equipment.

HYDRAULISCHE PROBLEME. Vorträge auf der Hydrauliktagung in Göttingen, June, 1925. V. D. I. Verlag, Berlin, 1926. Cloth, 6 × 8 in., 219 pp., illus., diagrams, 22.50 mk.

The addresses include a report on recent investigations of turbulence by L. Prandtl, experiments on cavitation and corrosion in turbines by H. Föttinger, cavitation in hydraulic turbines by D. Thoma, the improvement of turbine suction pipes by Osterlen, the approximation of flow losses and the problem of bends, the reactions at the blade tips of Kaplan turbines, the use of conformal representation in the calculation of currents in turbines by W. Spannhake, the ultimate number of vanes and the impossible working field of turbines by C. Pfleiderer, and anomalous flow in measuring nozzles by D. Thoma. The discussions of the papers are also given.

INVESTIGATION OF BUSINESS PROBLEMS; Technique and Procedure. By J. Eigelberner. A. W. Shaw Co., Chicago and New York, 1926. Fabrikoid, 6 × 9 in., 335 pp. $5.

The author attempts to analyze the subject of business investigation theoretically and practically and also to indicate a method of training in the art of investigation adapted to the needs of both business executives and workers in research.

LOKOMOTIVVERSUCHE IN RUSSLAND. By G. Lomonossoff. V.D.I. Verlag, Berlin, 1926. Cloth, 9 × 12 in., 330 pp., illus., diagrams, tables. 42 mk.

In the years 1898 to 1900, Professor Lomonossoff devised a method for testing locomotives by which the engine was subjected to the working conditions customary for laboratory tests, but on the actual roadway instead of in the laboratory. Wind resistance and the jolting from passage over the rails here introduce factors absent from laboratory tests. Since 1908 the method has been used in Russia to investigate each new type of locomotive. The present work presents some of the results of tests made from 1908 to 1923. The purpose and method of testing is first explained. The eight types of locomotives tested are then fully described, after which the results of tests on a locomotive of the newest Russian type are given in detail. The most important results of the tests of the remaining types of locomotives are then given. The final chapter illustrates the use of the experimental results for the solution of problems of locomotive operation.

METHODS OF MEASURING TEMPERATURE. By Ezer Griffiths. Second edition. Charles Griffin & Co., London, J. B. Lippincott Co., Philadelphia, 1926. Cloth, 6 × 9 in., 203 pp. illus., tables. 10s. 6d.

Written for those concerned with the measurement of temperature in scientific investigations or in industrial operations. Attention is given chiefly to the experimental basis of the methods in general use, the calibration of the instruments, and the precautions to be observed in practice. A connected account of the classical researches with the gas thermometer is given. Subsequent chapters deal with the mercury thermometer, the resistance thermometer, the thermocouple, the radiation pyrometer, and the optical pyrometer. References are appended to each chapter. The changes in this edition are, in addition to the correction of errata, chiefly in the portion on optical pyrometry.

Die Neuzeitliche Dampfturbine. By E. A. Kraft. V.D.I. Verlag, Berlin, 1926. Paper, 8 × 11 in., 124 pp., illus., diagrams, 7.50 mk.

Dr Kraft devotes himself to a discussion of some important recent developments in steam-turbine construction and of problems confronting the builder today. Referring the reader to other works for the theory of the turbine and the generalities of design, he turns at once to the latest efforts and discusses them critically. Special attention is given to efforts to increase economy by greater utilization of the heat, by improving operating methods and by improving efficiency. The correct lines for designing turbines of great economy are discussed and their application to various types illustrated. The questions of modern structural materials and of strength are also taken up.

New View of Surface Forces; A Collection of the Scientific Papers of Wilson Taylor. University of Toronto Press, Toronto, 1925. Cloth, 6 × 9 in., 240 pp., illus., diagrams, tables. A Memorial Volume.

When the author died, in 1923, after four years of research in physics, he left a number of papers, chiefly upon surface tension and molecular physics. Those here printed discuss the coalescence of liquid spheres and the law governing it, cohesion and adhesion in liquids and solids, the potential energy of free molecules, etc. One paper is devoted to flotation oils and their mode of action.

Power-Factor Wastes. By Charles R. Underhill. McGraw-Hill Book Co., New York, 1926. Cloth, 6 × 9 in., 326 pp., illus., diagrams, tables. $3.50.

This discussion of power-factor wastes is intended to present the subject from many points of view and thus to direct more attention to their importance. It aims to acquaint those responsible for these wastes with their causes, their cost and their cures. Many chapters are contributed by specialists on their subjects.

Principles of Physical Optics. By Ernst Mach. E. P. Dutton & Co., New York, 1926. Cloth, 6 × 9 in., 324 pp., illus., diagrams, $6.

In this work, as in his famous book on mechanics, Mach's aim is not so much a history as a statement of the progress of ideas concerning physical optics and of the manner in which they arose in the minds of their originators. The book is an interesting, instructive account of the development of the principles of physical optics, which will be welcomed by physicists generally.

Pyrometers. By Ezer Griffiths. Isaac Pitman & Sons, London and New York, 1926. Cloth, 5 × 7 in., 126 pp., illus., diagrams, tables. $2.25.

Intended as a connecting link between textbooks on heat and advanced treatises on pyrometry, this little book describes recent pyrometric apparatus, including expansion thermometers, thermo-electric pyrometers, resistance thermometers, an optical and total-radiation pyrometers. Only a few types of each class are described, but these have been selected from outfits designed to meet unusual requirements.

Railroad Electrification and the Electric Locomotive. By Arthur J. Manson. Second edition. Simmons-Boardman Publishing Co., New York, 1925. Cloth, 6 × 9 in., 332 pp., illus., diagrams, tables. $4.

Intended to provide information of value to those concerned with the operation and maintenance of electric locomotives, or interested in the general subject of railroad electrification. Technical detail is reduced to small dimensions, but the fundamental units and principles of electricity are explained, the design and construction of electric locomotives are described and illustrated, and the solutions of a number of practical problems incident to electrification are given. An appendix gives a brief history of electrification in the United States.

Regularization of Employment. By H. Feldman. Harper & Bros., New York, 1925. Cloth, 6 × 8 in., 437 pp., $3.50.

A study of the social and industrial effects of unemployment, of its causes, and of the various industrial, social, and governmental remedies that are available. Dr. Feldman considers all the important phases of industry and has collected a great number of plans used by business men to regularize production and employment. A book of interest to every manufacturer.

S.A.E. Handbook, March, 1926. Society of Automotive Engineers, New York, 1926. Fabrikoid, 4 × 7 in., various paging, diagrams, tables, $2.50 to members. $5.00 to non-members.

The standards and recommended practices of the Society of Automotive Engineers, some six hundred in number, have been revised and published in a bound volume of convenient pocket size, replacing the former data sheets supplied to its members. The contents are divided into sections relating to the power plant, lighting, electrical equipment, parts and fittings, materials, transmission, axles and wheels, tires, frames, etc. Revisions are to appear twice each year hereafter.

Sewage Purification and Disposal. By G. Bertram Kershaw. Second edition. University Press, Cambridge, 1925. (Cambridge Public Health Series.) Cloth, 6 × 9 in., 364 pp., illus., diagrams, tables. 18s.

This volume forms one of a series on public health published by the Cambridge University Press. The series is intended to supply information, both scientific and practical, in a manner that is not too technical, to physicians and others concerned with public health and hygiene. In the present volume, an experienced engineer endeavors to present concisely the most recent knowledge concerning sewage disposal and purification. The author discusses methods of conservancy, sewerage systems, the removal of suspended matter, sludge disposal, land treatment, contact beds, filters, sterilization, the treatment of trades wastes, and activated-sludge processes. Numerous data concerning the cost of various processes are given, and bibliographies lead to fuller information on the subject of each chapter.

Theory of Functions of a Real Variable and the Theory of Fourier's Series, v. 2. By E. W. Hobson. Second edition. University Press, Cambridge, 1926. Cloth, 7 × 10 in., 780 pp. 50s.

This important treatise, the first volume of which appeared in 1921, is now completed. The second volume deals with the theory of series and particularly of Fourier's series. The work has been greatly enlarged and almost entirely rewritten. It is stated to be the only book in the English language containing a systematic statement of many of the ideas introduced by modern mathematicians.

Von der Bewegung des Wassers und den Dabei Auftretenden Kräften—nach Arbeiten von Alexander Koch, edited by Max Carstanjen. Julius Springer, Berlin, 1926. Cloth, 8 × 11 in., 228 pp., illus., portraits, diagrams, 28.50 r.m.

During many years Dr. Koch was engaged at the Hydraulic Laboratory of the Darmstadt Technical High School in the investigation of the laws governing the motion of flowing water and of the force exerted by water in motion. His researches were directed to the discovery of principles upon which might be based a simple, clear, practical hydrodynamics which would enable hydraulic structures to be designed as safely and as readily as are bridges.

This book makes accessible the results obtained before the death of the author in 1923. An introductory chapter briefly summarizes principles. Potential energy and the laws of motion are then discussed. Succeeding chapters discuss the types of flow, discharge through wall openings and traveling waves. The appendix, amounting to one-fourth of the book, gives the results of certain investigations made at the Hydraulic Laboratory under Dr. Koch's direction. These include a study of the resistance of the experimental channel, of the transition from one type of flow to another, of the effect of contractions of the channel, and of discharge through openings or by overflow.

Die Wasserturbinen. By P. Holl; revised by Emil Treiber. Walter de Gruyter & Co., Berlin and Leipzig, 1926. Cloth, 4 × 6 in., 2 vols., 1.50 r.m. each.

By extreme compression and by the elimination of non-essentials, the author has succeeded in giving a very practical summary of the principles of the hydraulic turbine in these two small volumes. The first volume contains a general introduction on water power and turbines, followed by a discussion of the Pelton wheel and its regulating apparatus and of its applications. Volume two treats of the Francis turbine, covering its theory and structural principles, its construction and use, with some remarks on power plants.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

Characteristics and Application. Modern Grinding Practice, H. Darbyshire. Automobile Engr., vol. 16, no. 214, Apr. 1926, pp. 151–153, 4 figs. Consideration of nature of abrasive wheels and some notes on their application to production.

Standardization. International Standardization of Grain and Hardness of Grinding Wheels (Internationale Normung von Körnung und Härtegrad der Schleifscheiben), W. Glodde. Maschinenbau, vol. 5, no. 7, Apr. 1, 1926, pp. 317–318. Discusses connection between grain standards of German abrasives industry and N.D.I. screen standards; recommendation of international conference to examine grain standards for adoption in United States; proposes international standards for degrees of hardness of grinding wheels.

ACCIDENTS

First-Aid Instruction. The Importance of First-Aid Instruction in Works, E. N. Simons. Mech. World, vol. 79, no. 2048, Apr. 2, 1926, pp. 263–264. Describes organization of ambulance class in which three requirements must be fulfilled, namely, efficiency of material equipment, systematic methods, and capable instruction, each of which is discussed.

AIR COMPRESSORS

Hele-Shaw-Beacham. A New Form of Air-Compressor, H. S. Hele-Shaw and T. E. Beacham. Instn. Min. Engrs.—Trans., vol. 70, Apr. 1926, pp. 403–419 and (discussion) 419–431, 19 figs. Compressor which has been delivered to British Admiralty is of rotary type, main structural feature having been employed for several years in pump known as Hele Shaw, essential feature is saturation of incoming air with oil, this oil operating to lubricate both central valves and pistons; two features which are believed to be new are low temperature of delivery of compressed air owing to oil-saturation effect, and high volumetric efficiency at all pressures, due partly to small clearance and to oil filling clearance spaces.

AIR CONDITIONING

Humidifying. Air Humidification (Das letzte Wort zur Frage der Luftbefeuchtung), Bürgers and I. Fleischer. Gesundheits-Ingenieur, vol. 49, no. 13, Mar. 27, 1926, pp. 196–200. Discusses hygienic importance of humidification of air; gives results of tests showing that evaporation of water does not materially increase humidity.

Humidification of Air (Ueber Luftbefeuchtung), S. Muntner. Gesundheits-Ingenieur, vol. 49, nos. 13 and 14, Mar. 27 and Apr. 3, 1926, pp. 194–195 and 209–217, 20 figs. Production of humidity in presence of highly hygroscopic material, as in textile and tobacco works; tests carried out with Salinator apparatus and its advantages.

AIRCRAFT

Standardization of Parts. Army-Navy Standards, L. MacDill and R. S. Barnaby. Aviation, vol. 20, no. 20, May 17, 1926, p. 752. Standardization of aircraft parts, undertaken jointly by Army and Navy, will enable closer coöperation from procurement standpoint, and will be great advantage to aircraft industry.

AIRPLANE ENGINES

Curtiss. Standard Engine Test of Curtiss D-12 High and Low Compression Engines, J. W. Carl and W. W. Bishop, Jr. Air Service Information Circular, vol. 6, no. 550, Jan. 25, 1926, 33 pp., 43 figs. Tests to obtain information on design and performance of high- and low-compression Curtiss engines.

Developments. New Aircraft Engines, W. A. Bevan. Purdue Eng. Rev., vol. 21, no. 3, Mar. 1926, pp. 3–6 and 18, 6 figs. Development since the war of reliable motors with marked decrease in weight per horsepower.

Fuel-Injection Nozzles. Spray Penetration with a Simple Fuel Injection Nozzle, H. E. Miller and E. G. Beardsley. Nat. Advisory Committee for Aeronautics—Report, no. 222, 1926, 8 pp., 20 figs. Tests to obtain specific information on rate of penetration of spray from simple injection nozzle, having single orifice with diameter of 0.015 in. when injecting into compressed gases.

Naval. Aircraft-Engine Relations to the Needs of Naval Aviation, H. Schmidt. Soc. Automotive Engrs.—Jl., vol. 18, no. 5, May 1926, pp. 509–513, 1 fig. Discusses respective merits of air-cooled and water-cooled engines for aircraft, stating that up to about 450 hp. radial air-cooled engines developed by Navy have had decided advantage in weight per hp.; comparative ratings on basis of pounds per hp. when ready to fly are mentioned; discusses fuel consumption of both air-cooled and water-cooled engine and service acceptability for aircraft engines; advantages of air-cooled engines.

Packard. Low Weight and Compactness Feature Packard Aero Engines, L. S. Gillette. Automotive Industries, vol. 54, no. 15, Apr. 15, 1926, pp. 639–644, 10 figs. New 600-hp. model is 150 lb. lighter than war-time Liberty and delivers 200 hp. more; 800-hp. type is built along same lines.

AIRPLANE PROPELLERS

Blade-Element Theory. Propeller Design—Practical Application of the Blade Element Theory, F. E. Weick. Nat. Advisory Committee for Aeronautics—Tech. Notes, no. 235, May 1926, 14 pp., 11 figs. Describes blade-element or modified Drzewiecke theory as used in Bureau of Aeronautics, U. S. Navy Dept.; short method is shown in which forces on only one blade element are considered in order to obtain characteristics of whole propeller; methods described have proved satisfactory in use.

Interference. Airplane Propeller Interference Study, S. Ober. Tech. Eng. News, vol. 7, no. 1, Mar. 1926, pp. 12–13, 2 figs. First wind-tunnel tests are being made to reveal nature of natural airstream interference between airplane propeller and fuselage.

Metal. Metal Airscrews. Flight, vol. 18, no. 17, Apr. 29, 1926, p. 260, 2 figs. Comparative flying tests of Fairey-Reed on duralumin propeller of De Havilland 9.

AIRPLANES

Airfoils. Aerofoils, O. T. Sinnatt. Roy. Aeronautical Soc.—Jl., vol. 30, no. 185, May 1926, pp. 332–336, 5 figs. Describes method of considering air flow over upper front surface of airfoil which, although in no way exact, does give indication of what happens, and leads to explanation of most effective flying angle of airfoil.

Albatros. The Albatros L 72A. Flight, vol. 18, no. 15, Apr. 15, 1926, pp. 228–231, 5 figs. German newspaper carrier with slotted wings, tractor-biplane, all-metal type. See also Aeroplane, vol. 30, no. 15, Apr. 14, 1926, pp. 396 and 398.

Amphibian. Amphibian-Airplane Development, G. C. Loening. Soc. Automotive Engrs.—Jl., vol. 18, no. 5, May 1926, pp. 455–462, 15 figs. Historical precedents for some of main features of present amphibian airplane, and inventions, devices and procedure that have accompanied its development; analyzes disadvantages of previous types, and enumerates reasons for advantages claimed for new type, together with possible and probable uses to which amphibious airplane is suited.

Convertible Wings. Convertible Monoplane—Biplane Wings, R. F. Hall. Aviation, vol. 20, no. 17, Apr. 26, 1926, pp. 632–634, 7 figs. Results of wind-tunnel experiments on possibilities of compound wings.

Design Problems. Some Problems in Aeroplane Structural Design, H. B. Howard. Roy. Aeronautical Soc.—Jl., vol. 30, no. 184, Apr. 1926, pp. 238–260 and (discussion) 260–266, 11 figs. Deals with modern methods of airplane-strength calculations; tapered wing monoplanes; comparison of strip and Prandtl theories; staggered spars; normal accelerations.

Flight-Path Angle. N.A.C.A. Flight-Path-Angle and Air-Speed Recorder, D. G. Coleman. Nat. Advisory Committee for Aeronautics—Tech. Notes, no. 233, Apr. 1926, 11 pp., 13 figs. Describes new trailing bomb-type instrument for photographically recording flight-path angle and air speed of aircraft in unaccelerated flight; instrument consists essentially of inclinometer, air-speed meter, constant-speed motor and film-drum case.

Flight Tests. Flight Tests on Airplanes, H. Koppe. Nat. Advisory Committee for Aeronautics—Tech. Memorandums, no. 359, Apr. 1926, 31 pp., 18 figs. Results of author's tests. Translated from Berichte und Abhandlungen der Wissenschaftlichen Gesellschaft für Luftfahrt.

Gloster. The Gloster "Gamecock." Flight, vol. 18, no. 15, Apr. 15, 1926, pp. 218 and 221, 2 figs. Single-bay biplane fighter fitted with Bristol Jupiter engine.

Metal. Metal Airplane Construction. Nat. Advisory Committee for Aeronautics—Tech. Memorandums, no. 361, May 1926, 18 pp., 12 figs. Materials used, treatment, characteristics; principles and methods of construction. Paper read at Third Int. Congress of Aerial Navigation at Brussels, Oct. 1925.

Metal Construction of Airplanes, C. W. Hall. Aviation, vol. 20, no. 20, May 17, 1926, pp. 744–748, 9 figs. Detailed discussion of conversion of navy TS plane into duralumin-built F4C-1 plane; principles of and reasons for cambered spar.

Naval. Model Designation of Naval Airplanes. Aviation, vol. 20, no. 20, May 17, 1926, pp. 757–758. Full statement of system employed in designating naval-airplane designs.

Pander. The Pander Type E Sportplane. Aviation, vol. 20, no. 18, May 3, 1926, pp. 668 and 670, 2 figs. Two-seater plane with radial engine, built in Holland; it is, in general, of wood construction, upper wing being semi-cantilever thick-section structure with span of 33 ft. and chord of 3 ft. $3^1/_2$ in. equipped with 45-hp. Anzani 6-cylinder air-cooled engine.

Performance Prediction. A Simple Theoretical Method of Analyzing and Predicting Airplane Performance, I. H. Driggs. Air Service Information Circular, vol. 6, no. 553, Feb. 1, 1926, 8 pp., 4 figs. Gives formulas to show relation of certain fundamental variables to absolute ceiling and to rate of climb and to allow estimate to be made for these quantities with but minimum calculation.

Ryan. The Ryan M-1 Monoplane. Aviation, vol. 20, no. 19, May 10, 1926, pp. 712–713, 3 figs. Light commercial plane produced by Los Angeles-San Diego Passenger Airline Co. to be used on air-mail route from Seattle to Los Angeles equipped with Wright whirlwind 200-hp. air-cooled radial engine.

Spar Failure. The Lateral Failure of Spars, S.

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Bromley and W. H. Robinson, Jr., Nat. Advisory Committee for Aeronautics—Tech. Notes, no. 232, Mar. 1926, 18 pp., 10 figs. Conclusion, based on tests, is that after critical span or depth-breadth ratio has been reached, modulus of rupture varies approximately inversely as first power of span and of depth-breadth ratio; direction of lateral deflection is alternate between successive supports by theory and all tests; it is, therefore, believed that rib spacing along spar is more important in reducing lateral deflection than distance between supports at strut points.

Tailless. The Tailless Aeroplane. Engineer, vol. 141, no. 3670, Apr. 30, 1926, p. 501, 4 figs. on p. 498. Analysis of design; important features of tailless or split-tail design, and its advantages; features of criticism.

The Tailless Aeroplane, G. T. R. Hill. Engineering, vol. 121, no. 3148, Apr. 30, 1926, pp. 566–568, 4 figs. Details of design developed by author. (Abstract.) Paper read before Roy. Aeronautical Soc.

Udet Kondor. The Udet Kondor Airliner. Aviation, vol. 20, no. 18, May 3, 1926, pp. 674 and 676, 3 figs. New German monoplane built entirely of metal; 4 engines are hung under single internally braced wing; they are 100 hp. each and of air-cooled Siemens type, and drive pusher propellers through shaft extending to rear of trailing edge.

Wind Tunnels. See WIND TUNNELS.

AIRSHIPS

Framework-Stress Analysis. The Experimental Stress Analysis of Frameworks with Special Reference to the Problems of Airship Design, A. J. S. Pippard. Roy. Aeronautical Soc.—Jl., vol. 30, no. 185, May 1926, pp. 282–312 and (discussion) 313–322, 8 figs. Conclusions drawn from experiments: when tubular framework with redundant bracing is provided with efficient bracing in plane of applied load system, stresses in members tend quickly to become independent of arrangement of load system; provision of additional bracing in other planes parallel to that of loading produces much quicker equalization of stresses; if in design of such structures, as hull of rigid airship, formulas are used which determine stresses in members in terms only of resultant actions at section considered, it is important that effective bracing should be provided in plane of load system. See also paper by same author pp. 322–331, 1 fig., describing further experiments, object of which was to determine extent to which continuity of longitudinals affects stress distribution.

Polar Flight. The Transpolar Flight (Scopo dllee esplorazioni polari), U. Nobile. Annali dei Lavori Pubblici, vol. 63, no. 11, Nov. 1925, pp. 969–993, 13 figs. Reviews previous polar expeditions; details of design, construction and equipment of dirigible No. 1, built in Italy for polar flight; mooring mast at Spitzbergen.

Semi-Rigid. Development of Airship Construction in Italy (Sullo sviluppo delle construzioni dei dirigibili in Italia), V. Nobile. Rivista Aeronautica, vol. 2, no. 2, Feb. 1926, pp. 1–29, 26 figs. Design and equipment of types of 18,500, 1000, 7000, and 51,000 cu. m.; last-mentioned has length of 173.6 m., diameter 24.28 m., weight 29,000 kg., useful load 28,650 kg., speed 110 km. per hr., and 1410 hp.; mooring mast for semi-rigid airship.

Wireless Equipment. Wireless Equipment on the "Norge" Airship. Flight, vol. 18, no. 17, Apr. 29, 1926, pp. 255–256, 3 figs. Details of direction-finding system; special Marconi receiving apparatus, etc.

ALIGNMENT CHARTS

Construction and Use. Alignment Charts as Management Tools, F. J. Reuter. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 367–368, 1 fig. Shows how costs of infrequent and complicated drawing-room and production-office calculation may be lowered by use of alignment chart; application for analysis and layout purposes.

ALLOY STEELS

Analyses. Report of the Austrian Industrial Standards Committee (Normblattentwürfe), Sparwirtschaft, no. 2, Feb. 1926, pp. N17–N23, 1 fig. Proposed standards for analyses of high-grade steels for determination of carbon, manganese, silicon, phosphorus, copper, nickel, chromium, tungsten, molybdenum, titanium, cobalt, etc.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Brass. See BRASS.

Composition. Composition of the Technically Most Important Metal Alloys (Zusammensetzung der technisch wichtigsten Metall-Legierungen). Zeit. für die gesamte Giessereipraxis (Metall), vol. 47, nos. 3 and 4, Jan. 17 and 24, 1926, pp. 10–11 and 14–15. List of alloys alphabetically arranged, giving their trade names and composition.

Magnesium. See MAGNESIUM ALLOYS.

ALUMINUM ALLOYS

Aluminum-Magnesium. The Constitution of the Alloys Al-Mg from 32 to 48 Per Cent Mg., T. Halstead and D. P. Smith. Am. Electrochem. Soc.—Advance Paper, no. 24 for mtg. Apr. 26, 1926, pp. 327–347, 9 figs. Investigation of alloys ranging from 32 to 48 per cent magnesium; determination of thermo-electromotive force and temperature coefficient of resistance of series of these alloys; results indicate that there exist two regions of solid solution, in place of single Beta field found by earlier investigators.

Castings. Aluminium-Alloy Permanent-Mould Castings, R. J. Anderson. Foundry Trade Jl., vol. 33, nos. 494, 495, 496, 498, 501 and 502, Feb. 4, 11, 18, Mar. 4, 25 and Apr. 1, 1926, pp. 93–94, 105–108, 125–128, 173–174, 237 and 255–256, 13 figs. Feb. 4: Permanent-mold and semi-permanent-mold casting process; die-casting process; sand founding. Feb. 11: Advantages and disadvantages in comparison with sand and die castings. Feb. 18: Uses and field of application; specific kinds of castings produced in permanent molds. Mar. 4: Kinds of alloy used; factors affecting casting behavior; particular alloys used for casting. Mar. 25: Sizes and size tolerances; weights and weight tolerances. Apr. 1: Manufacture, design and gating; essentials of permanent-mold process; gating methods.

Heat Treatment and Foundry Practice. Aluminum Alloys in Engineering, H. Hyman. Roy. Tech. College Met. Club Jl., no. 5, 1926, pp. 21–24. Notes on heat treatment and foundry practice.

AMMONIA COMPRESSORS

American and German. Comparison between German and American Design of Rotary Ammonia Compressors (Kritischer Vergleich zwischen rotierenden Ammoniakverdichtern deutscher und amerikanischer Bauart), W. Tamm. Zeit. für die gesamte Kälte-Industrie, vol. 33, no. 2, Feb. 9, 1926, pp. 23–26, 4 figs. Discusses development of Güttner and Macintire types, and gives results of tests carried out; effect of number of revolutions, of temperature of condensation and of evaporation; concludes that German type is superior as to operating conditions, American is superior for very high number of revolutions and very low temperature of evaporation.

APPRENTICES, TRAINING OF

Foundry. Adopt Principles for Apprentice Training. Foundry, vol. 54, no. 9, May 1, 1926, pp. 362–363. Report of committee on foundry training covering principles for coöperative apprenticeship training, approved by New England Foundrymen's Assn.

Railway. Railway Apprentice Training, T. C. Gray. Ry. Mech. Engr., vol. 100, no. 5, May 1926, pp. 269–271. Points out that skilled, thoroughly trained mechanics must be provided; what should limit number of apprentices; apprentice system on Missouri-Kansas-Texas lines.

ARTILLERY

Anti-Aircraft. Is Anti-Aircraft Artillery Overtaking the Airplane? H. E. Cloke. Sci. Am., vol. 134, no. 5, May 1926, pp. 301–303, 8 figs. Discusses different forms of altimeters and anti-aircraft guns; it is predicted that positive and highly efficient system of anti-aircraft defense will be realized during coming year.

AUTOMOBILE ENGINES

Crankcase-Oil Dilution. Lubrication Data from Coöperative Fuel Research, S. W. Sparrow and J. O. Eisinger. Indus. & Eng. Chem., vol. 18, no. 5, May 1926, pp. 482–485, 4 figs. Report based on study of crankcase-oil dilution; research showed that fuels of unusually low volatility often increased crankcase-oil dilution to extent which precluded their use.

Principles Underlying the Use of Equilibrium Oils for Automotive Engines, R. E. Wilson and R. E. Wilkin. Indus. & Eng. Chem., vol. 18, no. 5, May 1926, pp. 486–490, 7 figs. Presents first theoretical analysis of dilution and development of fundamental laws, assuming that dilution approaches equilibrium condition in crankcase; experimental data from road tests and dynamometer trials were obtained to determine constants and to test validity of these laws.

Fuel-Saving Design. Mechanical Design to Realize Best Economy of Fuel, S. W. Sparrow. Engrs. & Eng., vol. 43, no. 4, Apr. 1926, pp. 100–104 and (discussion) 104–111, 2 figs. Discusses factors which influence fuel consumption, that is, miles obtainable per gallon of fuel by ordinary automobile.

Fuels. See AUTOMOBILE FUELS.

Ignition Equipment. Electric Ignition Equipment, A. C. Burgoine. Automobile Engr., vol. 16, no. 214, Apr. 1926, pp. 154–158, 9 figs. Details of ignition equipment from practical point of view, introducing theoretical questions only when necessary to make clear certain points or arguments; deals with spark energy, magnetos, coil ignition, combined ignition and lighting machines, impulse starters, automatic timing control and sparking plugs.

Lubrication. Automotive Engine Lubrication, A. W. Pope, Jr. Indus. & Eng. Chem., vol. 18, no. 5, May 1926, pp. 490–492, 6 figs. Pertinent facts pertaining to modern practice; splash system is most widely used, but because of certain shortcomings when used for heavy-duty high-speed work, pressure system is coming into increased favor; combination of pressure and splash system has been worked out to give satisfaction for general automotive use; oil purification by elimination of solids from oil and control of dilution.

Superchargers. The Practical Application of Superchargers to Automobile Engines, C. W. Iseler. Soc. Automotive Engrs.—Jl., vol. 18, no. 5, May 1926, pp. 516–520 and 523, 3 figs. Describes Mercedes supercharged engine and analyzes performance of car with and without superchargers; analysis and comparison of power curves show that acceleration from 10 to 30 m.p.h. is much more rapid with supercharger, in both high and intermediate gear and maximum speed is increased from 40 to 50 per cent; engine without supercharger has characteristics of low-speed engine, and supercharged engine those of high-speed engine.

AUTOMOBILE FUELS

Coal, Recovery from. Availability of Petroleum Substitutes from Coal, A. C. Fieldner. Engrs. & Eng., vol. 43, no. 4, Apr. 1926, pp. 96–99. Methods of obtaining automobile fuel from coal; yields from low-temperature carbonization; future prospects; Bergius process; synthetic fuel from water gas; other sources of automotive energy.

Ignition of Carbureted Mixtures. Ignition of Carbureted Mixtures by Adiabatic Compression (Sur l'nflammation adiabatique des mélanges carburés), A. Pignot. Académie des Sciences—Comptes Rendus, vol. 182, no. 6, Feb. 8, 1926, pp. 376–377. Mixtures were subjected to fixed volumetric compression and initial temperature necessary for ignition was determined; by plotting ignition temperature against percentage of hydrocarbon or alcohol, curves are obtained which sharply differentiate between aromatic and saturated hydrocarbons; with volumetric compression of 9, benzene and alcohol give similar curves; increasing amounts of water in alcohol result in flattening of curve.

Synthetic. Synthetic Motor Spirit from Mixtures of Carbon Monoxide and Hydrogen, E. Audibert. Fuel, vol. 5, no. 4, Apr. 1926, pp. 170–177. Formation of methane by contact with various metals; formation of pure methyl alcohol by contact with suboxides. Translated from Chimie & Industrie, 1925, p. 186.

Synthetic Substitute Fuels (Les carburants synthétiques de remplacement), Génie Civil, vol. 88, no. 10, Mar. 6, 1926, pp. 232–234. Preliminary report of French Commission showing extent of its investigation and generally negative results.

AUTOMOBILE MANUFACTURING PLANTS

Willys-Knight Production Methods. Willys-Knight Production Methods, F. H. Colvin. Am. Mach., vol. 64, no. 14, Apr. 8, 1926, pp. 551–554, 12 figs. Methods used in selecting and assembling pistons, pins and connecting rods that will give best service in completed engine.

AUTOMOBILES

Axle Casings, Machining. Machining Rear Axle Casings. Automotive Engr., vol. 16, no. 214, Apr. 1926, pp. 142–143, 5 figs. Single-purpose equipment of standard machines for boring and drilling axle casings.

Bianchi. The 10–15-H.P. Bianchi Chassis. Automobile Engr., vol. 16, no. 214, Apr. 1926, pp. 120–126, 17 figs. Details of type S4 chassis; departure from conventional is found in mounting of gear box upon end of torque tube; 4-cylinder engine with overhead valves drives through single-plate clutch and 4-speed gear box to spiral bevel axle; semi-elliptic springs are fitted at both axles and brakes are provided on all 4 wheels.

Headlighting. A Possible Solution of the Headlighting Problem, H. M. Crane. Soc. Automotive Engrs.—Jl., vol. 18, no. 5, May 1926, pp. 467–469 and (discussion) 469–473, 8 figs. Proposed method of headlighting from experiments made with car having standard equipment consisting of head lamps provided with parabolic reflectors and Bausch & Lomb lenses mounted 36 in. above road surface; separate switch permits extinguishment of left headlight alone; suggests possibility of using diffused light produced by large-diameter frosted bulbs on cars of low price and moderate speed.

Lanchester. The 21 H.P. Six-Cylinder Lanchester. Auto-Motor Jl., vol. 31, no. 15, Apr. 15, 1926, pp. 311–313, 8 figs. Engine, clutch and gear form single unit; valves are enclosed overhead and operated by worm-driven overhead camshaft; crankshaft is nickel-chrome steel machined from solid forging and is hollow; cooling is by honeycomb radiator; suspension is by Lanchester flexible cantilever springs at rear.

Lubrication. Chassis Lubrication, F. H. Gleason. Soc. Automotive Engrs.—Jl., vol. 18, no. 5, May 1926, pp. 491–496 and 499, 11 figs. Describes system which derives its lubricant from central source; experimental work since 1924 and improvements in system resulting therefrom, layouts and constructions used in connection with this system; oil pressures maintained in different parts.

Metallurgique. The Metallurgique. Auto-Motor Jl., vol. 31, no. 12, Mar. 25, 1926, pp. 247–249, 9 figs. Details of latest model of Belgium car; 4-cylinder engine of monobloc design and constructed in one unit with clutch and gear; power is transmitted from it by propeller shaft enclosed in long torque tube; lubrication is automatic and under pressure.

Rear Axles. Ajax Rear Axle Design Simplifies Production Methods, W. L. Carver. Automotive Industries, vol. 54, no. 16, Apr. 22 1926, pp. 680–684, 9 figs. All operations on housing and differential carrier performed on relatively few machines; ten men produce from 150 to 175 units per day; parts light enough to be moved without tackle.

Schneider. The 10–30 H.P. TH. Schneider. Auto-Motor Jl., vol. 31, no. 14, Apr. 8, 1926, pp. 296–298, 8 figs. New 10–30-hp. model, having 4-cylinder engine; cooling is entirely by thermosiphonic action; engine is mounted in pressed-steel chassis frame on 3-point suspension.

Springs and Drive, Interaction of. Action of Springs Should Not Affect Uniformity of Transmission, P. M. Heldt. Automotive Industries, vol. 54, no. 17, Apr. 29, 1926, pp. 730–731, 3 figs. With most types of drive, when springs of chassis deflect under road shock, slight angular motion is set up in transmission, either at engine end, road end, or both; reference to new German commercial vehicle, Mannesmann-Mulag chassis, in which low frame height is obtained without resorting to expensive kick-up in frame; construction also reduces unsprung weight at rear and makes it possible to use propeller-shaft type of universal with only the least "universalling" action.

Tires. See TIRES, RUBBER.

AVIATION

Air-Mail Service. Operation of the Air Mail and Its Possible Application to Commercial Operations, J. E. Whitbeck. Mech. Eng., vol. 48, no. 5, May 1926, pp. 465–467. Flying equipment, ground personnel, and airways and airports; equipment in commercial operations; single-engined vs. three-engined planes; safety in flying; probable costs in commercial operation.

Anti-Aircraft Defense. Antiaircraft Defense,

L. H. Ruggles. Army Ordnance, vol. 6, no. 35, Mar.-Apr. 1926, pp. 344-354, 3 figs. Functions and weapons of anti-aircraft defense; effectiveness as indicated by World War records; defense of Paris; tests at Ft. Tilden, 1925; firings at Aberdeen Proving Ground; night firing.

B

BALANCING MACHINES

Recording Amplimeter for. New Type of Recording Amplimeter Is Used on Precision Balancing Machine. Automotive Industries, vol. 54, no. 15, Apr. 15, 1926, p. 649, 2 figs. Pointer becomes stationary at maximum reading of instrument, enabling one operator to tend several machines.

BEARINGS

Lubrication. Lubrication of Plain Bearings, D. P. Barnard. Soc. Automotive Engrs.—Jl., vol. 18, no. 5, May 1926, pp. 483-485, 2 figs. With view to making investigation of behavior of oil after it has reached bearing, visual study was made by means of glass bearing and results were reproduced by film, action of lubricant being made visible by introducing into oil small quantity of dyed glycerine solution of about the same viscosity as oil; results obtained.

Oil Flow in Plain Bearings, D. P. Barnard. Indus. & Eng. Chem., vol. 18, no. 5, May 1926, pp. 460-462, 6 figs. Attempts to present basic laws of fluid lubrication in such manner that they may be readily used in correlation of test data; simple method of development of approximate laws controlling oil flow through bearings, due both to pressure developed in film and to oil-feed pressure and experimental data in substantiation of this method.

BEARINGS, BALL

Steel-Mill Machinery. Application of Anti-Friction Bearings to Steel Mill Machinery, G. R. Holmes. Iron & Steel Engr., vol. 3, no. 2, Feb. 1926, pp. 104-105, 1 fig. Applications of ball and roller bearings to electrical and other equipment in steel mills.

BELTING

Initial Length of. Initial Length of Belt. H. Noguchi. Soc. Mech. Engrs. (Tokyo, Japan)—Jl., vol. 29, no. 107, Mar. 1926, pp. 123-134, 1 fig. Formula is worked out in which it is possible to calculate initial length of initial tension of belt required for necessary operative condition; in this formula weight of belt itself and elastic elongation are taken into account. (In Japanese.)

BLAST FURNACES

Blowing Practices. A Method of Determining Comparable Blowing Practices for Iron Blast-Furnaces, J. S. Fulton. Engrs.' Soc. West. Pa.—Proc., vol. 41, no. 10, Jan. 1926, pp. 460-470 and (discussion) 471-475, 2 figs. Actual delivery of free air; weight of oxygen per cu. ft. of air; pounds of coke per long ton of iron; chemical analysis of coke.

Cast-House Arrangement. Cast House Arrangement Unusual. Iron Age, vol. 117, no. 19, May 13, 1926, pp. 1338-1340, 4 figs. Cast-house of no. 2 blast furnace of Youngstown Sheet & Tube Co., Indiana Harbor, Ind., marks new departure in design; spur from hot metal track extends under cast-house roof, which provides protection for ladles during casts; to facilitate handling materials in and out of cast house, cast-house crane is mounted on runway spanning hot metal track; furnace has 16 tuyeres of 700-tons.

Design. Some Observations Regarding Blast-Furnace Design, A. G. McKee. Engrs.' Soc. West. Pa.—Proc., vol. 41, no. 10, Jan. 1926, pp. 391-406 and (discussion) 407-411, 11 figs. Trend of design and future developments.

Stack Built for Low-Cost Output, R. A. Fiske. Iron Age, vol. 117, no. 20, May 20, 1926, pp. 1424-1426, 5 figs. Recent completion of No. 4 blast furnace of Inland Steel Co., Indiana Harbor, Ind., will result in 40 per cent increase in pig-iron output; in addition, it is anticipated that production costs at new furnace will be materially lower than in ordinary practice. See also description by E. C. Barringer in Iron Trade Rev., vol. 78, no. 20, May 20, 1926, pp. 1306-1308, and 1315, 7 figs.

Stoves. Modern Blast-Furnace Stoves, A. E. Maccoun. Engrs.' Soc. West. Pa.—Proc., vol. 41, no. 10, Jan. 1926, pp. 412-414 and (discussion) 415-427. Brief summary of modern blast-furnace stove development.

BLOWERS

Centrifugal. Fundamental Principles for Predetermining the Most Important Properties of Blowers (Grunder för bedömandet av fläktars viktigaste egenskaper), F. Tenelius. Teknisk Tidskrift (Mekanik), vol. 56, no. 12, Mar. 20, 1926, pp. 31-37, 12 figs. Discusses fundamental properties of blowers, particularly centrifugal blowers; application of fundamental equation established by Euler to various blower combinations; formulas obtained in this manner should have great usefulness in discussing experimental blower data.

BOILER FEEDWATER

Meters. Choice of Boiler Feedwater Meters (Ueber die Auswahl von Kesselspeisewassermessern), Vosskämper. Braunkohle, vol. 24, no. 51, Mar. 20, 1926, pp. 1105-1111, 10 figs. Describes current types and shows advantages of disk meters, or where they cannot be used, of venturi meters; rotary and Waltmann meters are less suitable.

BOILER FURNACES

Air Preheaters. Air Preheating for Combustion. Power Engr., vol. 21, no. 241, Apr. 1926, pp. 128-129, 1 fig. Useful figures and methods of calculation; advantages of air heating; Howden-Ljungström air heater; Thermix air heaters and others of plate type.

Temperatures and Heat Utilization in an Air Preheater (Temperaturen und Wärmeausnutzung in einem Luftvorwärmer), Hakanson and H. Zander. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 14, Apr. 3, 1926, pp. 471-474, 2 figs. Purpose of air preheating; review of air preheaters of recuperative and regenerative system; working process of Ljungström air preheater; calculation of efficiency and temperatures; approximate formulas.

The Perry Preheater. Power Engr., vol. 21, no. 242, May 1926, pp. 170-172, 1 fig. New type of air preheater for boiler furnace which has been designed so that it can be accommodated in any available space not more than 7 ft. wide; principle employed is that of moving elements which become heated by products of combustion passing over their surfaces and afterwards give up their heat to incoming air when they move into that part of apparatus.

Arches. Designing Boiler Furnace Arches, H. C. Thayer. Power Plant Eng., vol. 30, no. 8, Apr. 15, 1926, pp. 473-474. Points out that flat arch is better than sprung type; arch height is governed by variable conditions.

Combustion Control. The New Combustion Control System, G. G. Hollins. Elec. Light & Power, vol. 4, no. 5, May 1926, pp. 126-129, 6 figs. Details of system installed at Livingston plant of Staten Island Edison Corp., based on metering functions controlled; air flow is measured by drop in pressure through last two passes of boiler.

Grate Bars. Behavior of Grate Bars in Service (Roststäbe und ihr Verhalten im Feuer). Bergbau, vol. 39, no. 11, Mar. 18, 1926, pp. 158-159. Factors influencing life of grate bars are enumerated, and effect of various impurities in determining chemical and physical changes in metal is considered; graphite in bars of gray cast iron tends to make metal porous and therefore more liable to oxidation and penetration of other chemical actions; white cast iron is better material for this purpose, cementite withstanding heat and chemical attack to greater degree; denser structure prevents penetration of attacking gases, and even thermal decomposition of cementite, with formation of free carbon, does not involve same disadvantages as presence of graphite.

Refractories. See REFRACTORIES, BOILER-FURNACE.

BOILER PLANTS

Instruments. The Instrument Layout from the Investment Viewpoint. Power, vol. 63, no. 20, May 18, 1926, pp. 766-768. Economic principles underlying intelligent selection of power-plant instruments.

BOILERS

Combined Producer-Gas and Pulverized-Fuel. A New System of Steam Generation. Eng. & Boiler House Rev., vol. 39, no. 10, Apr. 1926, pp. 469-472, 3 figs. Combined application of producer gas and pulverized fuel embodied in Gyro system of firing evolved by F. L. Duffield; Gyro gasifier consists of round or oval gasifying chamber into which pulverized fuel enters tangentially. See also description in Elec. Rev., vol. 98, no. 2525, Apr. 16, 1926, pp. 609-611, 4 figs.

Efficiencies. Industrial-Boiler Efficiencies, S. D. Fitzsimmons. Mech. Eng., vol. 48, no. 5, May 1926, pp. 412-414, 1 fig. Results obtained with two boilers installed at plant of Brown & Sharpe Mfg. Co., Providence, R. I., indicating desirability of low furnace-draft velocities and more effective use of radiant heat; premise is assumed that more width in tube sections of water-tube boilers is desirable.

Flues. Proposed New Design for Lancashire Boiler Flues, J. G. Kirkland. Eng. & Boiler House Rev., vol. 39, no. 10, Apr. 1926, pp. 479-480, 1 fig. Idea is to reduce to minimum amount of flanging, drilling, turning, riveting, caulking and caulking rings obtaining in present-day design.

Gas-Fired. Surface Combustion Principle Applied to Gas-Fired Boilers, C. H. S. Tupholme. Gas Age-Rec., vol. 57, no. 15, Apr. 10, 1926, pp. 512 and 542, 1 fig. Details of Woodall-Duckham Co.'s gas-fired boiler specially designed to incorporate principles of surface combustion.

High-Pressure. Steam Plants of Very High Pressure (Dampanlæg med medget höje tryk). Ingeniören, vol. 35, no. 1, Jan. 2, 1926, pp. 1-6. Design and data of Borsig 60-atmos. plant, Atmos plant of Svenska Sockerfabriks A.B., at Gothenburg; Benson and Löffler boilers.

Indirect Steam Generation. Steam Generated Indirectly in German Experimental Boiler. Power, vol. 63, no. 20, May 18, 1926, p. 776, 1 fig. Test boiler designed for operation at 900-lb.-per-sq. in. pressure and for indirect production of steam in drum equipped with heating coils. Translated from V.D.I. Nachrichten, Mar. 17, 1926.

Pulverized-Coal-Fired. Huge Boiler to Operate at 1,390-lb. in Lakeside Station. Power, vol. 63, no. 20, May 18, 1926, p. 771, 1 fig. Boiler, by Babcock & Wilcox Co., for Milwaukee plant, is to burn pulverized coal and have special arrangement of water walls and radiant superheaters.

Scale Prevention. New Electrical Process for Prevention of Boiler Scale and Corrosion. Eng. & Boiler House Rev., vol. 39, no. 10, Apr. 1926, pp. 488 and 491. Particulars of new Hauptvogel system for prevention of scale and for counteracting corrosion, which is said to be self-regulating; process consists of supplying weak d.c. electric current to boiler shell which acts as protecting current and therefore differs from other electrical methods which are based on partial electrolysis; known as Contra-Current electrical process.

Water-Level Alarm. Boiler Water Level Alarm. Eng. & Boiler House Rev., vol. 39, no. 10, Apr. 1926, p. 492, 1 fig. Should water level in boiler rise or fall to dangerously high or low limits it is now possible to have these conditions immediately indicated to attendant by means of Gordon high- and low-water alarm and level indicator.

Water-Level Gages, Distant. Distant Water Gauge Indicators, E. Ingham. Power Engr., vol. 21, no. 242, May 1926, pp. 166-168, 8 figs. Principles relating to such gages and typical designs.

BOLTS

Wrench-Head. Tentative American Standard for Wrench-Head Bolts and Nuts and Wrench Openings. Mech. Eng., vol. 48, no. 5, May 1926, pp. 537-538. Standard prepared by committee under sponsorship of American Soc. Mech. Engrs. and Soc. of Automotive Engrs.

BONUS SYSTEMS

Successful Application. Bonus System Pays in Hoosier Plant, E. G. McQuinn. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 329-334, 9 figs. Since installation of group bonus in various departments, plant of Hoosier Mfg. Co. at New Castle, Ind., has broadened its range of products considerably; in spite of which organization has been able to extend new bonus plans to include these new products with result that bonus is operating as satisfactorily now as when originally designed.

BRASS

Annealing. Notes on Annealing Brass. Foundry Trade Jl., vol. 33, no. 506, Apr. 29, 1926, p. 341. Discusses causes of losses during annealing and means of preventing them.

BRASS FOUNDRIES

Equipment. A Western Brass Foundry. West. Machy. World, vol. 17, no. 4, Apr. 1926, pp. 163-164, 3 figs. Methods and equipment of Standard Brass Casting Co., Oakland, Cal.; includes four oil-fired tilting-type Schwartz furnaces, and three crucible furnaces; core oven is oil-fired.

BROACHING MACHINES

Hydraulic. New Hydraulic Broaching Machine Provides Wide Range of Cutting Speeds. Automotive Industries, vol. 54, no. 16, Apr. 22, 1926, p. 694, 1 fig. Improved variable-speed machine placed in production by J. N. Lapointe Co., New London, Conn.

C

CABLEWAYS

Aerial Tramways. Warden Mine Installs Aerial Tramway to Dump Four Hundred Tons of Refuse Daily. Coal Age, vol. 29, no. 18, May 6, 1926, pp. 629-630, 4 figs. Rock and picking table rejects fall into steel bin and is loaded alternately into one of two 2-ton cars which carry it out on leg of triangular tramways system.

Funicular. Automatic Car Control for Funicular Railways. Brown Boveri Rev., vol. 13, no. 3, Mar. 1926, pp. 67-75, 8 figs. Automatic remote control both for d.c. and a.c. drives placed on market by Brown-Boveri & Co., who have developed automatic starters for three-phase systems, fully complying with all demands; details of Fürigen-Harissenbucht funicular.

Ore-Handling. Ore-Handling in Morocco by Mono-Cable Ropeway. Indus. Mgmt. (Lond.), vol. 13, no. 4, Apr. 1926, pp. 161-162, 3 figs. General layout of conveying plant capable of handling 300 tons of ore per hr.

Slackline. Slack Line Cableways in Finnish and Swedish Cement Plants. Cement Mill & Quarry, vol. 28, no. 6, Mar. 20, 1926, pp. 20 and 22, 3 figs. Details of 1-cu. yd. Sauerman slackline cableway, designed to excavate clay and gravel in Pargas and Finland; and 1½-cu. yd. slackline cableway in Sweden for excavating marl containing many huge bolders.

CAMS

Indexing Motion. The Cam Indexing Motion, B. Sassen. Am. Mach., vol. 64, no. 18, May 6, 1926, pp. 705-707, 6 figs. Principle of indexing by cams and its application; unlimited number of stations and possibility of higher speeds give advantage over Geneva stop motion.

CARS

Dynamometer. Road Tests Influence Locomotive Design, H. A. Campbell. Ry. Rev., vol. 78, no. 17, Apr. 24, 1926, pp. 769-770. Points out that data obtained with dynamometer car are as valuable as those derived from testing plants; results of tests made by Pennsylvania R.R. and by Paris, Lyons and Mediterranean Ry.

CAST IRON

Electric Melting. Cast Iron from Electric Furnaces. Iron Age, vol. 117, no. 11, Mar. 18, 1926, p. 760. Duplexing with cupola in Germany; peculiar properties observed; pig iron unnecessary; high-grade castings from poor scrap. Based on paper delivered by Kerpeley at convention of German foundrymen in Berlin.

Engineering Practice. Cast-Iron and Modern Engineering Practice, J. G. Pearce. Instn. Mech. Engrs.—Proc., no. 6, 1925, pp. 1231-1241. Discusses relationship between engineering and foundry; output of gray iron; character of research on cast iron; coöperative research; standard specifications.

Fire-Resistant. A New Fire-Resistant Casting

(Ein neuer feuerbeständiger Guss), E. Schüz. Feuerungstechnik, vol. 14, no. 11, Mar. 1, 1926, pp. 127–128, 5 figs. Results of series of tests carried out on alloys suitable for fire-resisting parts; it was found possible to produce a casting, which is greatly superior to all unalloyed iron and steel in its fire-resistive qualities; its strength is at least equal to that of high-grade gray cast iron; new product, known as Alferon, is suitable for furnace parts in place of ordinary iron and steel.

Gray. Why Is Gray Iron Porous? H. M. Ramp. Foundry, vol. 54, no. 9, May 1, 1926, pp. 354–355. Conclusions based on years of experience and observation in gray-iron foundry practice.

Pearlitic. Some Further Notes on Pearlitic Cast Iron, J. E. Hurst. Foundry Trade Jl., vol. 33, nos. 494 and 506, Feb. 4 and Apr. 29, 1926, pp. 95–97 and 333–335, 4 figs. Feb. 4: Properties; Perlit Method; Perlit iron without heating molds; criticism of Diefenthaler's curves. Apr. 29: Concludes that attempt to relate chemical composition, thickness of casting and mold temperatures by series of straight-line curves, as outlined in patent specifications of Perlit process, results in serious anomalies and absurdities; influence of mold temperature on structure of cast iron and relation between mold temperature and composition; except for fact that somewhat lower silicon iron than normally used can be cast in hot mold, it is unlikely that hot mold confers any structure or distribution of structure throughout mass of casting which cannot be duplicated in cold mold.

The Lanz-Perlit Cast-Iron Process. Mar. Engr. & Motorship Bldr., vol. 49, no. 584, Apr. 1926, p. 134. Lighter and stronger iron castings obtained by employing newly introduced manufacturing process.

Testing. Testing Method for Cast Iron (Prüfverfahren von Gusseisen), P. Wolff. Stahl u. Eisen, vol. 46, no. 17, Apr. 29, 1926, pp. 560–564, 6 figs. Relation between tensile strength, compressive strength and hardness; different rapid testing methods; evaluation and comparison of test results.

Titanium, Effect on. Effect of Titanium on Cast Iron, E. Piwowarsky. Iron Age, vol. 117, no. 19, May 13, 1926, pp. 1340–1341, 2 figs. Action similar to silicon but more active; effect on mechanical properties. (Abstract.) Translated from Stahl u. Eisen, vol. 43, 1923, p. 1491.

Total Carbon Content. The Total Carbon Contents of Cast Iron, J. E. Hurst. Engineering, vol. 121, no. 3149, May 21, 1926, pp. 583–584, 2 figs. Points out that effect of low total-carbon content on constitution of commercial foundry irons is deeper than would be imagined at first sight; two principal constituents, carbon and silicon, have been taken into consideration, utilizing ternary constitutional diagram of iron-carbon-silicon alloys; this enables more complete conception to be obtained of constitutional changes which occur.

CASTING

Machines. Pours Work in Casting Machine, W. W. McCarter. Foundry, vol. 54, no. 8, Apr. 15, 1926, pp. 317–319, 12 figs. Describes casting machine designed by author used to make variety of castings of ferrous and non-ferrous metals.

CASTINGS

Tolerances. Casting Tolerances, W. J. May. Mech. World, vol. 79, no. 2051, Apr. 23, 1926, p. 326. Points out that with castings made in metal molds there should always be fixed tolerances for excess shrinkage where there is any great variation in melting or rather pouring temperature, because although all grades of some particular metal may not melt and be fit for pouring at one particular heat, rate of expansion and contraction per degree of heat remains practically constant.

CENTRAL STATIONS

Diesel-Engined. Diesel Operated Municipal Plants, R. V. Cook. Power House, vol. 19, no. 7, Apr. 5, 1926, pp. 23–24, 1 fig. Author claims that Diesel engine is making possible success of municipal stations, effecting reduction in expense and saving in labor.

Largest Privately Owned Diesel Utility Plant in America. Southern Power Jl., vol. 44, no. 4, Apr. 1926, pp. 36–38, 5 figs. Diesel-engined plant of 2100 e.hp. and 1400-kw. capacity at Hollywood, Fla.

Industries, Relation to. The Central Station and Industrial Power, R. C. Muir. Gen. Elec. Rev., vol. 29, no. 5, May 1926, pp. 298–301. Relationships between producer and user; advantages of central-station service; importance of industrial load to central stations; responsibility for power-factor improvement.

Load Analysis, United States and Canada. Data on Output and Peak Load of Largest Generating and Distributing Companies in the United States and Canada. Elec. World (Supp.), vol. 87, no. 17, Apr. 24, 1926. Table I: Data include power and electric railway companies in United States and Canada having yearly output in excess of 100,000,000 kw-hr. during 1925. Table II (on reverse side): Contains data on generator rating, output, load factor, customers and distribution of energy of all companies having output over 100,000,000 kw-hr. during 1925.

Hundred-Million-Kilowatt-Hour Utilities. Elec. World, vol. 87, no. 17, Apr. 24, 1926, pp. 855–857. United States has 110 such systems; energy produced by these represents 81 per cent of country's total generation.

Middletown, Pa. Design and Test of Susquehanna Station Metropolitan Power Company, J. A. Powell. Iron & Steel Engr., vol. 3, no. 4, Apr. 1926, pp. 167–174, 10 figs. Equipped with 30,000-kw., 18,000-r.p.m. 17-stage General Elec. Co. turbo-generator; 45,000-sq. ft. single condenser, 4 Connelly boilers with Lopulco pulverizers and fuel equipment, etc.; details of coal-preparation plant; data obtained during tests.

Narragansett. Enlarged Narragansett Plant Embodies Unusual Engineering Features, H. Couch and R. L. Blanding. Power, vol. 63, no. 18, May 4, 1926, pp. 664–669, 5 figs. New 35,000-kw. turbine in station of Narragansett Elec. Lighting Co. bleeds up to 60 per cent of throttle steam for feed heating; steam at 375-lb. and 200-deg. superheat supplied by four 20,000-sq. ft. boilers, which burn pulverized fuel and are equipped with 3 different types of air preheaters; new turbine exhausts to world's largest single-body jet condenser; huge hot-process softener used.

Oil-Engined. Heavy-Oil Engine Installations—Choice of Site and Lay-Out of Plant, G. Porter. Diesel Engine Users Assn.—Report of Discussion, no. 50, Feb. 19, 1926, 35 pp., 11 figs. Deals with application of heavy-oil engine to electric drive, especially in reference to power stations carrying on business of generating electrical energy for distribution in extensive area.

Operating Performance. Experiences with Modern Stations. Elec. World, vol. 87, no. 19, May 8, 1926, pp. 983–993, 8 figs. Operating performance of some modern plants and their experience with firing method, steam extraction, reheating and air preheating; detailed experiences with powdered fuel; stoker experiences; experience with main unit bleeding.

Philadelphia. Philadelphia Electric Company's Richmond Station. Power, vol. 63, no. 20, May 18, 1926, pp. 740–747, 8 figs. Station designed for 600,000 kw. in 3 independent sections of 200,000 kw. each; boilers of 15,697 sq. ft. used with economizers and air heaters in same settings; steam conditions 375-lb. gage, 675 deg. fahr.; 3-stage bleeding from main units and motor-driven auxiliaries, starting at full voltage.

Richmond Goes on the Line with 100,000 Kilowatts. Power Plant Eng., vol. 30, no. 10, May 15, 1926, pp. 564–573, 11 figs. New generating station of Philadelphia Elec. Co. will have ultimate capacity of at least 600,000 kw.; arrangement for heating feedwater is based on regenerative cycle and each of 50,000-kw. turbine units is provided with 3 bleeder heating stages designed to deliver 600,000 lb. of water per hr. to boilers at 305 deg. fahr.; tabular data of principal equipment.

Rocky Mount, N. C. Rocky Mount, N. C., Installs Modern Power Plant. Power, vol. 63, no. 15, Apr. 13, 1926, pp. 550–553, 7 figs. New municipal electric light plant at Rocky Mount, N. C., uses high-pressure steam in latest design of turbine; modern equipment employed throughout; total capacity of 7500 kw. contemplated.

Somerset, Mass. The Somerset Power Station, J. F. Muir. Stone & Webster Jl., vol. 38, no. 4, Apr. 1926, pp. 461–491, 9 figs. New station located at Taunton River; initial installation consists of one 32,000-kw. turbine-generator unit with three 1492-hp. Stirling boilers; steam pressure of 350 lbs. per sq. in. and total temperature of 700 deg. was adopted; fuel oil is being used for steam generation, but provisions have been made so that pulverized coal can be burned whenever it becomes desirable.

CHIMNEYS

Calculation. Standard Calculations for Chimneys (Berechnungsnormen für Schornsteine), Tonindustrie-Zeitung, vol. 50, no. 13, Feb. 13, 1926, pp. 203–205. Proposed standards for calculating stability of high, self-supporting chimneys, admissible stresses in brickwork and reinforced concrete, foundations, lining and fittings.

COAL

Pulverized. See PULVERIZED COAL.

Wet vs. Dry. Wet v. Dry Coal, A. Page. Power Engr., vol. 21, no. 241, Apr. 1926, pp. 138–139. Disadvantages and losses due to wet coal; consideration of combustion conditions with added moisture; advantages and gains due to wetting coal.

COAL HANDLING

Central Stations. Coal and Ash Handling at Warrior Reserve Plant, A. T. Hutchins. Elec. Light & Power, vol. 4, no. 5, May 1926, pp. 89–92, 4 figs. Details of coal washer installed to reduce ash content of coal; coal-storage and handling equipment; ash handling, sampling and analyses.

Towers. Coal Towers of Reinforced Concrete (Kohlentürme aus Eisenbeton), H. Butzer. Bauingenieur, vol. 7, no. 10, Mar. 5, 1926, pp. 195–204, 15 figs. Design of various types executed by Butzer Co., including towers of Borsig Works, and various German mines.

COAL STORAGE

Power Plants. Coal Storage for Power Plants, C. H. S. Tupholme. World Power, vol. 5, no. 26, Feb. 1926, pp. 90–92. It has been shown that mass of very small, uniform coal particles has no practical effect in retarding diffusion of oxygen through it, and proportion of voids in very fine coal when uniformly sized, is same as in lump coal; mixing different sized pieces in mass tends to reduce proportion of voids; building coal pile so as to reduce or prevent segregation of large and small pieces will lessen proportion of voids in pile, tend to keep down amount of oxygen entering pile by diffusion, and thus reduce oxidation from this source.

COMBUSTION

Temperature. Combustion Temperature and Its Graphic Determination (Die Verbrennungstemperatur und ihre graphische Ermittlung), W. Gunz. Feuerungstechnik, vol. 14, no. 10, Feb. 15, 1926, pp. 109–112, 8 figs. Graphic determination of combustion temperature, taking into consideration air preheating and radiation; loading capacity of pulverized-coal combustion chambers is given as example.

COMPRESSED AIR

Explosions. Explosions in Compressed-Air Plants (Explosionen in Druckluftanlagen), F. Ritter. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 16, Apr. 17, 1926, pp. 543–544. The small quantities of oil fog present in compressed-air pipes, containers, etc., can, through decomposition through electrical processes, but especially through adiabatic compression, be brought to explosion; whereas protective means have been found to prevent violent explosive wave, no means have been found to prevent ignition of oil-soaked ferric oxides.

CONDENSERS, STEAM

Surface. Regarding Experimental Confirmation of Nusselt Theory on Heat Transmission in Surface Condensers (Intorno alla conferma sperimentale della teoria del Nusselt relativamente alla fase di trasmissione vapore-parete nei condensatori a superficie), M. Medici. Industria, vol. 40, no. 3, Feb. 15, 1926, pp. 58–60, 6 figs. Concludes from experiments that values resulting from Nusselt equation are too low, and more so, the higher the velocity of steam.

CONDUITS

Pressure. Calculating Loss in Pressure Conduits (Calcul de la perte de charge dans les galeries sous pression), J. Calame and D. Gaden. Bul. Technique de la Suisse Romande, vol. 52, no. 7, Mar. 27, 1926, pp. 74–80. Discusses various coefficients used for calculating pressure loss in water conduits, gives tables of these for circular conduits perfectly smooth and lined with concrete; average value of coefficient of friction.

Stresses Due to Temperature in Lined Pressure Tunnels (Gallerie in pressione con rivestimenti tensioni per azioni termiche), U. Puppini. Energia Elettrica, vol. 3, no. 1, Jan. 1926, pp. 1–7. Continuation of previous mathematical study published in same journal (Sept. 1925), devoted to calculation of pressure tunnels when lining of cement, reinforced concrete or sheet iron has different coefficients of elasticity and expansion from those of rock.

CONNECTING RODS

Resistance to Flexure. Calculation of Resistance to Flexure of Connecting Rods for High-Speed Engines (Nota sul calcolo della resistenza alla flessione delle bielle dei motori Velocissimi), A. Capetti. Industria, vol. 11, no. 4, Feb. 28, 1926, pp. 88–90, 2 figs. Discusses method of simple approximate calculations for bending tests, relation of inertia load to speed of engine.

CONVEYORS

Overmotoring. Preventing Overmotoring of Conveyors, R. F. Emerson. Power, vol. 63, no. 19, May 11, 1926, pp. 703–704, 1 fig. Points out that conveyors are probably overmotored to greater extent than any other type of materials-handling machinery.

COOLING TOWERS

Fillers. Use of Raschig Rings in Refrigeration (Ueber die Verwendung von Raschig's Ringen in der Kälte-Industrie), Buschmann. Zeit. für die gesamte Kälte-Industrie, vol. 33, no. 1, Jan. 9, 1926, pp. 7–10, 3 figs. Discusses application of Raschig cylindrical fillers of sheet metal, porcelain, etc., used for accelerating reactions between gases and liquids moving in counter-currents by increasing surface of contact, in cooling towers for either wet or dry process, production of liquid air, etc.

CORES

Making. The Coreroom and Its Product, R. Micks. Can. Foundryman, vol. 17, no. 5, May 1926, pp. 12–14. Mechanical devices for making cores; selection of sand for making various types of cores; arrangement of core room; distribution of flues in core oven.

CORROSION

Boiler Parts. Corrosion of Boiler Parts (Ueber eigenartige Korrosionserscheinungen an Dampfkesselteilen), R. Stumper. Feuerungstechnik, vol. 14, no. 11, Mar. 1, 1926, pp. 121–123, 5 figs. Corrosion on surface of screw plugs of a header was traced to combined effect of steam, dripping water and combustion gases; screw plugs were of copper and header of cast iron; for prevention of corrosion, author recommends use of iron screw plugs having same coefficients of expansion as header material, which would make closing tighter.

Protective Media. The Deterioration and Conservation of Materials (Stoffverfall und Stofferhaltung), H. L. Meurer. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 14, Apr. 3, 1926, pp. 461–467, 15 figs. Points out importance of conservation of engineering materials; disadvantages of paint as protection against corrosion; most important galvanizing processes used for rust proofing; physical and chemical adaptability; applications of metal-spray process.

Resisting Finishes. Some Corrosion Resisting Finishes. Foundry Trade Jl., vol. 33, no. 502, Apr. 1, 1926, p. 261. Deals with two types of corrosion-resisting treatments; namely, those that depend on diffusion of one metal into surface of another, and those that depend on chemical treatments.

CRANES

Shipbuilding. The Crane Equipment of Shipbuilding Berths, E. Smith. Shipbldg. & Shipg. Rec., vol. 27, no. 14, Apr. 8, 1926, pp. 407–412, 12 figs. Data on costs at 1925 prices, of various systems to be considered in article; deals with heavy and braced derricks and stationary tower cranes; pre-erection. (Abstract.) Paper read before Instn. Naval Architects.

CRANKSHAFTS

Bending and Torsional Strains. Bending and Torsional Strains and Stresses in a Loaded Crank Shaft, H. Carrington. Engineer, vol. 141, no. 3671, May 21, 1926, pp. 520–521, 5 figs. Results of experiments on crank of 4-throw type for use in engine giving 30 b.hp. at 1500 r.p.m.; method of measuring strains; results of torsion and bending experiments.

CUPOLAS

Design. Cupola Design, E. A. Roper. Foundry

Trade Jl., vol. 33, no. 503, Apr. 8, 1926, p. 272. Points out disadvantages of straight-line cupolas.

CUTTING METALS

Flame-Cutting Speeds. Flame-Cutting Speeds. Mech. World, vol. 79, no. 2051, Apr. 23, 1926, pp. 322–323, 7 figs. Details of Gewe automatic plate-cutting machine, which is motor-driven with adjustable speeds controlled by worm and friction drive and Gewe shaft-cutting appliance; and other cutting and profiling machines.

CYLINDERS

Heads, Machining. Ajax Cylinder-Head Production. Machy. (N. Y.), vol. 32, no. 9, May 1926, pp. 707–709, 7 figs. Machine line-up that enables two men to maintain continuous production of one cylinder head every five minutes.

Cylinder Heads of the New Stutz "Eight," F. H. Colvin. Am. Mach., vol. 64, no. 17, Apr. 29, 1926, pp. 671–673, 7 figs. Special milling and drilling methods in machining cylinder heads of universal design, at low cost; double-purpose for milling.

D

DIE CASTING

Process. Die Casting (Der Spritzgusz), L. Frommer. Werkstattstechnik, vol. 20, nos. 4 and 6, Feb. 15 and Mar. 15, 1926, pp. 99–120 and 177–202, 72 figs. Description of working process; die casting of zinc and aluminum. Process of filling mold in die-casting; prerequisites for obtaining perfect castings and relation of these prerequisites to die-casting apparatus; flow of metal in mold; theory of motion in ideal, loss-free flow; flow of metal in die. Pressure distribution in mold; flow phenomenon and practical application of flow tests.

DIESEL ENGINES

Application and Operation. Application and Operation of Diesel Engines, G. A. Adkins and R. H. Bacon. Power Plant Eng., vol. 30, no. 9, May 1, 1926, pp. 529–532, 3 figs. Points out that conditions affecting costs must be analyzed for specific conditions. Paper presented before Chicago Section of Am. Soc. Mech. Engrs. See also Power, vol. 63, no. 17, Apr. 27, 1926, pp. 653–654, 2 figs.

Busch-Sulzer. Busch-Sulzer Completes Diesel Test. Power Plant Eng., vol. 30, no. 10, May 15, 1926, pp. 606–607, 2 figs. Results of 30-day shop test upon first engine completed by this company for U. S. Shipping Board.

Heat Transmission in. Heat Transmission in Diesel Engines (Der Wärmeübergang in der Dieselmaschine), W. Nusselt. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 14, Apr. 3, 1926, pp. 468–470, 5 figs. Influence of average piston speed on heat transmission, as expressed in formula developed by author in 1923, has been most satisfactorily confirmed by tests of Nägel on a Sulzer 2-stroke marine Diesel engine of 1600 hp. See reference to author's original article on this subject in Eng. Index 1923, p. 386.

Lubrication. A Problem in Diesel Engine Lubrication, F. Norton and R. R. Matthews. Indus. & Eng. Chem., vol. 18, no. 5, May 1926, pp. 480–481. Considers condition as found in one plant and steps taken to correct it.

Diesel Lubrication, P. L. Scott. Indus. & Eng. Chem., vol. 18, no. 5, May 1926, pp. 477–480, 4 figs. Describes oil requirements for different parts of engine and various mechanisms for feeding oil to these parts in order to prevent sources of trouble; brings out value of clean oil and suggests several methods for accomplishing this.

M.A.N. M.A.N. Double-Acting 2-Cycle Engine. Motorship (N. Y.), vol. 11, no. 5, May 1926, pp. 367–370, 6 figs. Details of 15,000-b.hp. engine; principal features of 6-cylinder engine built for motorship Ramses, developing 4400 b.hp at 84 r.p.m.

The New Double-Acting Two-Stroke Marine Diesel Engine of the M.A.N. (Der neuer doppeltwirkende Zweitakt-Schiffsdieselmotor der M.A.N.), W. Laudahn. Schiffbau, vol. 27, no. 6, Mar. 24, 1926, pp. 147–161, 20 figs. Details of new 6-cylinder engine built for cargo motorship, Ramses of Deutsch-Austral & Kosmos Lines, developing 4400 hp. at 84 r.p.m.; air enters through duct serving middle of cylinder and passing through independent ports in cylinder walls to upper and lower cylinder ends; all ports are on one side of cylinder unit, this arrangement having been found most efficient; trial results.

Oil Fuels for. Fuel Oils for Diesel Engines, W. A. P. Schorman. Power House, vol. 19, no. 7, Apr. 5, 1926, pp. 26–27, 2 figs. Characteristics of three classes of oil suitable for Diesel engines; ignition difficulties; importance of providing efficient filters for oil.

Supercharging. New Thoughts on Supercharging Oil Engines, R. Matthews. Power, vol. 63, no. 20, May 18, 1926, pp. 774–776. Points out that opinion is divided on merits of supercharging 4-stroke-cycle Diesel engines; author advances idea of supercharging during combustion.

Worthington. Worthington Builds New Diesel Engine. Power Plant Eng., vol. 30, no. 8, Apr. 15, 1926, pp. 478–482, 10 figs. Development of double-acting two-cycle engine makes possible lighter engines with same power and materially reduces maintenance.

DISKS

Inertia Forces. Inertia Forces Resulting in Moving Disks (Die resultierenden Trägheitskräfte bewegter Scheiben), H. Alt. Zeit. für angewandte Mathematik und Mechanik, vol. 6, no. 1, Feb. 1926, pp. 58–62, 10 figs. Details of method for determining resulting inertia forces for disks under any co-planar movement; pole of acceleration; application to disks rotating round a fixed axis.

DRILLING MACHINES

Multiple-Spindle. Multiple Spindle Drilling Machines. Brit. Machine Tool Eng., vol. 3, no. 38, Mar.-Apr. 1926, pp. 384–390, 14 figs. Types of this class of machine placed on market by J. Archdale & Co., Birmingham, Eng.

Piston-Pin Holes. Machines for Drilling Piston Pin Holes Introduced in Three Sizes. Automotive Industries, vol. 54, no. 18, May 6, 1926, pp. 776–777, 3 figs. Machines, marketed by Hoefer Mfg. Co., Freeport, Ill.

Single-Head. A New Machine for the Locomotive Wheel Shop. Brit. Machine Tool Eng., vol. 3, no. 38, Mar.-Apr., 1926, pp. 379–381, 2 figs. Machine for drilling and tapping of holes for locomotive screws; manufactured by Wm. Asquith, Ltd.

DYNAMOMETERS

Air-Brake. The Heenan-Fell Air Brake Dynamometer. Engineering, vol. 121, no. 3147, Apr. 23, 1926, p. 546. New form in which principle of varying area of air-outlet orifice to an enclosed fan chamber has been adopted; one advantage is that brake is practically silent.

E

EDUCATION, ENGINEERING

Civil Engineering. A Study of Engineering Curricula, W. C. John. Eng. Education—Jl., vol. 16, no. 8, Apr. 1926, pp. 517–549, 3 figs. Deals with subjects of entrance requirements and requirements for graduation in civil engineering.

Freshman Course. The Freshman Engineering Problems Course, B. B. Bessesen. Eng. Education—Jl., vol. 16, no. 8, Apr. 1926, pp. 564–572. Describes course which is outgrowth of study and training given to Student Army Training Corps during war, at Oregon Agricultural College.

Metallurgy. The Metallurgical Student and the Industry. Metallurgist (Supp. to Engineer, vol. 141, no. 3670), Apr. 30, 1926, pp. 49–50. Discusses German and American system of technological training, with highly developed specialization, which author does not consider applicable to British conditions and ideas. Review of discussion at inter-university conference, held in Birmingham, Eng.

ELECTRIC FURNACES

Carbonizing and Hardening. Carbonizing and Hardening Steel. Iron Age, vol. 117, no. 11, Mar. 18, 1926, pp. 764–765, 2 figs. Continuous electric furnaces of pusher type for carbonizing automobile gears and pinions placed in operation by Hudson Motor Car Co., Detroit; represents important forward step in electric heat-treating furnace design as aid to mass production; built by Holcroft & Co., Detroit.

High-Frequency Induction. High-Frequency Induction Furnaces (Der Hochfrequenz-Induktionsofen), F. Wever. Stahl u. Eisen, vol. 46, no. 16, Apr. 22, 1926, pp. 533–536, 6 figs. Describes high-frequency melting installation in Kaiser-Wilhelm-Institut für Eisenforschung; advantages as compared with low-frequency furnaces with annular hearth, from metallurgical and energy-saving standpoint.

ELECTRIC LOCOMOTIVES

Italy. New Locomotives of the Milan-Varese-Porto Ceresio Line (Nuovi locomotori per la linea Milano-Varese-Porto Ceresio), Rivista Tecnica delle Ferrovie Italiane, vol. 29, no. 1, Jan. 1, 1926, pp. 1–3, 1 fig. Equipped with single-reduction motors of 1000-hp. direct current at 650 volt; speed, 65 to 85 km. per hr.; tractive force, 5000 kg.

Switzerland. High-Speed Locomotives of Swiss Federal Railways (Les Locomotives à grande vitesse des chemins de fer féderaux suisses), F. Collin. Vie Technique & Industrielle, vol. 7, no. 76, Dec. 1925, pp. 160–163 and vol. 8, no. 76, Jan. 1926, pp. 235–238, 18 figs. Design and equipment of 1 B-B type for 300-ton trains, gradients of 25 per cent and speed of 50 km. per hr.; 1 C type, capable of moving 628-ton trains on 10-per cent gradient, tractive effort 15,000 kg.; speed 65–90 km. per hr.; monophase motor cars and their equipment for trains of 100–150 tons.

Virginian Railway. Mechanical Design of Virginian Electric Locomotive. Ry. Mech. Engr., vol. 100, no. 5, May 1926, pp. 272–274, 6 figs. Hauling-capacity rating of locomotive built by American Locomotive Co. and Westinghouse Electric & Mfg. Co.; maximum adhesion requires 900,000 lb. of adhesive weight for necessary 270,000 lb. of tractive force; details of wheel arrangement; motor drive, draft gear, etc.

ELECTRIC RAILWAYS

Dining Cars. First All-Electric Dining Car. Elec. Traction, vol. 22, no. 4, Apr. 1926, pp. 191–192, 3 figs. New diner completed by Interstate Public Service Co. is equipped with electric kitchen and other apparatus.

ELECTRIC WELDING, ARC

Autogenous. Autogenous Welding by Means of A.C. Arc (La soudure autogène à l'arc électrique au moyen du courant alternatif), G. Burnand. Bul. Technique de la Suisse Romande, vol. 52, no. 2, Jan. 16, 1926, pp. 16–19, 9 figs. Compares oxyacetylene, d.c. and a.c. welding; types of transformers, tests of welds; gives cost data for comparison.

Electrodes, Deposit Efficiency of. Deposit Efficiency of Electrodes, J. B. Green. Welding Engr., vol. 2, no. 4, Apr. 1926, pp. 21–24, 5 figs. Study of factors affecting percentage of electrode deposited in weld zone by metallic arc.

Hydrogen. Atomic Hydrogen Arc Welding. Welding Engr., vol. 2, no. 4, Apr. 1926, pp. 31–32, 2 figs. Process developed in Schenectady Research Laboratory employs double tungsten electrode and jet of hydrogen gas.

Welding in an Atmosphere of Hydrogen. Forging—Stamping—Heat Treating, vol. 12, no. 4, Apr. 1926, pp. 136–139, 5 figs. Discusses two methods for producing ductile welds developed by research scientists of General Electric Co.

Mild Steel. The Metallurgy of an Electric-Arc Weld in Mild Steel, A. G. Bissell. Am. Welding Soc.—Jl., vol. 5, no. 3, Mar. 1926, pp. 8–16, 10 figs. Discusses complicated metallurgical changes that occur in immediate vicinity of arc.

ELEVATORS

Electric Drive. Electric Drive of Elevators (La commande électrique des monte-charges et ascenseurs), A. Curchod. Revue Générale de l'Electricité, vol. 19, no. 12, Mar. 20, 1926, pp. 453–465, 12 figs. Short history of development of motor-driven passenger elevators; desirable characteristics of motors suitable for this type of service; shows what d.c. and a.c. motors can best be used; methods of motor control; details of Otis-Pifre micro-drive; electrical and mechanical safety devices for elevators to guard against drop of cabin and overrunning of end position.

Starting and Stopping. Rates of Starting and Stopping Elevators and Their Effect on Service, H. B. Cook. Power, vol. 63, no. 19, May 11, 1926, pp. 715–718, 5 figs. Author presents subject in easily understood manner; simple way to compute traveling time.

EMPLOYEES' REPRESENTATION

System. Building Worker-Management Relations on Full Sharing of Facts, C. F. Dietz. Factory, vol. 36, no. 4, Apr. 1926, pp. 627–630, 4 figs. Prescribes system of employing representation adopted by Bridgeport Brass Co., Bridgeport, Conn.

EMPLOYMENT MANAGEMENT

Personnel Selection. Problems in Personnel, E. Schlesinger. Indus. Mgmt. (N. Y.), vol. 71, no. 5, May 1926, pp. 295–297. Selection of young engineers for technical staff.

ENERGY

Cost of Production. Possibilities of Reducing Cost of Energy. Elec. World, vol. 87, no. 17, Apr. 24, 1926, pp. 870–871. 12,000 B.t.u. per kw-hr. seen as immediate limit with present steam cycles, better with combination cycles; capital expenditures and coal-handling costs.

ENGINEERING

Character and Definition. The Character of Engineering (Wesen der Technik), A. Riedler. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 14, Apr. 3, 1926, pp. 457–460. Author gives various definitions of purpose of engineering, its fundamental function being to ensure necessities of human life; it is defined as art of creating values through technical means, art of winning and utilizing energy from natural forces, etc.; cultural value of engineering; its misuse.

ENGINEERS

Registration. Progress of Registration for Engineers, G. E. Taylor. Professional Engr., vol. 10, no. 4, Apr. 1926, pp. 7–8. Reasons for registration; points out that one of weak points in many of existing registration laws for professional engineers is method of enforcement of act; registration in West Virginia; registration by counties, technical societies and by individuals.

Training for Executive Positions. Qualifying Engineers for High Executive Positions, H. A. Guess. Min. & Met., vol. 7, no. 233, May, 1926, pp. 213–214. Essentials for new education; points out that recent graduate usually takes job as junior engineer; hence schools should give thorough training in engineering essentials. Review of discussion at joint meeting of New York Sections of four National Societies.

ENTROPY

Absolute Constant of. Absolute Constant of Entropy and Its Applications (La constante assoluta dell'entropia e le sue applicazioni), F. Rasetti. Nuovo Cimento, vol. 3, no. 1–2, Jan.-Feb. 1926, pp. 67–85. Shows that classical thermodynamics is insufficient for complete calculation of chemical equilibrium of reaction; calculates entropy of perfect monatomic gas; develops quantistic hypothesis and finds a value for absolute entropy.

Definition. A New Statistical Definition of Entropy (Eine neue statistische Definition der Entropie), M. Planck. Zeit. für Physik, vol. 35, no. 3, Dec. 23, 1925, pp. 155–169. Based on quanten statistics, a new general definition of entropy is developed, which does not require any probability suppositions and reaches beyond field of thermodynamics.

EXECUTIVES

Relations of Chief to Associates. The Relations of the Chief Executive to His Principal Associate Executives, H. S. Person. Taylor Soc.—Bul., vol. 11, no. 2, Apr. 1926, pp. 47–51. Discusses fundamental and detailed aspects of relationship.

Training for Automobile Industry. The Training of Future Executives, J. Younger. Soc. Automotive Engrs.—Jl., vol. 18, no. 5, May 1926, pp. 479–481. Suggestion is made that Society of Automotive Engrs. and National Automobile Chamber of Commerce should appoint educational committees and by maintaining contact with educational institutions, assure that teaching shall represent modern practices.

F

FATIGUE

Industrial. Fatigue From a New Point of View, H. W. Haggard. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 363–366. Physiological maintenance of human machine in industry; fatigue in relation to capacity for work; points out that feeling of fatigue is not dependent on energy expended; recovery from fatigue; factors in rate of human production; influence of environment on capability, and of air cooling on output.

FIREBRICK

Properties. Fireclay Bricks, E. R. Thews. Foundry Trade Jl., vol. 33, no. 506, Apr. 29, 1926, pp. 339–341. Properties which refractory bricks employed for construction and lining of metallurgical furnaces should possess; liability to spalling; cementing desiderata; painting brickwork faces; cupola walls and iron oxides; jointing.

FLOW OF FLUIDS

Measurement. The Measurement of Fluid Flow, P. F. Foster. Mech. World, vol. 79, nos. 2035, 2039, 2043, 2046 and 2049, Jan. 1, 29, Feb. 26, Mar. 19 and Apr. 9, 1926, pp. 10–11, 86–87, 165–166, 227–228, and 282–283, 12 figs. Jan. 1: Measurement of rate of discharge for small flows by orifice method. Jan. 29: Employment of large uncalibrated orifice for flow measurement, etc. Feb. 26: Principle and development of Venturi meter. Mar. 19: Application of Bernoulli's theorem on flow of gas. Apr. 9: Methods of measuring air speeds.

FLOW OF WATER

Conduits. Flow of Water in 54-in. Concrete Conduit, Denver, Colo., F. C. Scobey. Eng. News-Rec., vol. 96, no. 17, Apr. 29, 1926, pp. 678–680, 3 figs. Two tests of combined length of 7.2 miles show average capacity greater by 15 per cent than that accepted for best conduits of few years ago.

Open Channels. The Measurement of Large Volumes of Water, F. J. Taylor. Commonwealth Engr., vol. 13, no. 7, Feb. 1, 1926, pp. 255–257, 6 figs. Discusses essential principles of bulk-water measurement.

FLUE-GAS ANALYSIS

CO_2 and CO Recorders. The Mono CO_2 Distant Indicator. Power Engr., vol. 21, no. 241, Apr. 1926, pp. 146–147, 2 figs. By use of suitable apparatus analyses of Duplex Mono CO_2 and Co. instrument may be indicated or recorded in any desired position.

FLUMES

Intakes for. Intakes for High Velocity Flumes, C. W. Harris and J. B. Hamilton. Univ. Wash.—Bul., no. 33, Sept. 1, 1925, pp. 5–27, 12 figs. Ideal shape of intake; design; apparatus and methods of conducting tests; selection of type of intake.

FLYWHEELS

Failures. Flywheel Failures. Universal Engr., vol. 43, no. 4, Apr. 1926, pp. 22–23, 1 fig. Discusses common causes of overspeeding or racing.

FOREMEN

Training. Training Foremen to "Manage," G. L. Gardiner. Indus. Mgmt. (N. Y.), vol. 71, no. 5, May 1926, pp. 290–295. Foremanship-development program of Oakland Motor Car Co.

FORGING

Machine. Marked Progress in Machine Forging, C. D. Harmon. Forging—Stamping—Heat Treating, vol. 12, no. 4, Apr. 1926, pp. 122–126, 10 figs. Comparison of machine forging and drop forging; points out that quality of machine forgings has been improved to degree not generally appreciated.

FORGING MACHINES

Universal. Universal Forging Machine. Machy. (Lond.), vol. 28, no. 706, Apr. 8, 1926, pp. 37–39, 5 figs. Machine developed by B & S Massey, Manchester, Eng.; combining characteristics of hydraulic press with those of forging hammer.

FORGINGS

Internal Defects. Internal Defects in Forgings, F. W. Rowe. Metal Industry (Lond.), vol. 28, no. 16, Apr. 16, 1926, p. 365, 2 figs. Case of internal defect in forging of 3½ per cent nickel chrome-steel which had been oil hardened and tempered to 55–65 tons after rough machining.

FOUNDRIES

Aluminum. Aluminum Foundry Practice, G. Mortimer Foundry Trade Jl., vol. 33, nos. 503, 504, 505 and 506, Apr. 8, 15, 22, and 29, 1926, pp. 279–281, 293–295, 307–310, and 329–332, 16 figs. Apr. 8: Value of adding copper; disability of zinc; use of manganese; making alloys. Apr. 15: Melting practice and temperature control; plumbago crucibles; iron pots; reverberatory-type furnace; importance of pouring temperature; effect of occluded gases, total shrinkage, and slow cooling. Apr. 22: Sand casting. Apr. 29: Fixing height of pouring; use of snap flasks; dressing; soldering; welding; plugging and doping; recovery of waste material.

Artificial Illumination. Artificial Illumination in Foundries. Iron & Steel Engr., vol. 3, no. 4, Apr. 1926, pp. 179–181, 2 figs. Advantages of good lighting in foundries; intensity of illumination and maintenance; selection of lighting equipment.

Automobile Plants. Making Cadillac Car Castings. Foundry, vol. 54, no. 10, May 15, 1926, pp. 383–387, 10 figs. Cylinder blocks made on sand-throwing machine are molded and poured in three-part flasks with barrels in vertical instead of horizontal position; cleaning castings.

Cost Accounting. Are You Making Wild Guesses or Estimates? A. E. Grover. Foundry, vol. 54, no. 8, Apr. 15, 1926, pp. 304–307 and 325. Points out that false assumptions on past performances prove heavy handicap in setting prices for foundry work; suggests detailed method of study of various departmental costs.

Fluxes, Application of. Application of Fluxes, Etc., in the Foundry, W. J. May. Mech. World, vol. 79, no. 2048, Apr. 2, 1926, pp. 266–267. In author's opinion, selection of metal and skill of melter should make use of fluxes unnecessary in production of sound castings, but this, of course, is different from adding desirable constituents to baths of molten metal which is really form of alloying.

Materials Handling. Lifting and Shifting Appliances in Foundries, H. H. Moore. Foundry Trade Jl., vol. 33, no. 502, Apr. 1, 1926, pp. 247–253 and (discussion) 253–254, 6 figs. Two elementary principles should be borne in mind: (1) in handling material carry out only operations that are absolutely necessary; (2) perform these operations in way that secures lowest cost. Electric cranes; sand handling; battery trucks; mass production in foundry.

Research, Application of. Some Applications of Research to Modern Foundry Practice, J. E. Fletcher Instn. Mech. Engrs.—Proc., no. 6, 1925, pp. 1243–1261 and (discussion) 1261–1273, 8 figs. Author seeks to illustrate example of method of attack used in applying results of research to current foundry practice; skin defects, shrinkage and contraction; trend of future developments in cast iron.

Scientific Control. Scientific Control in a Foundry, B. E. Williams. Rugby Eng. Soc.—Proc., vol. 19, session 1924–5, pp. 35–58, 23 figs. Deals with control in buying molding sand; requirements of molding sands for various alloys; carbon, silicon, manganese, phosphorus and sulphur in cast iron; pearlitic cast iron.

FREIGHT HANDLING

Mechanical Equipment. Mechanizing Handling of Freight (Die Mechanisierung des Güterumschlags), D. Przygode. Glasers Annalen, vol. 98, nos. 6 and 7, Mar. 15 and Apr. 1, 1926, pp. 87–96 and 112–113, 18 figs. Methods and apparatus for unloading and reloading between ships, ship and shore, etc.; design of loading bridges and crane equipment, automatic unloaders, etc.

FRICTION

Aspects. Some Aspects of Friction, W. A. Benton. Engineer, vol. 141, nos. 3667, 3668 and 3669, Apr. 9, 16 and 23, 1926, pp. 403–405, 430–431 and 458–459, 6 figs. With particular reference to significance for engineers. Indication of present position regarding surfaces nominally unlubricated or sparingly lubricated; conclusions and suggestions to which author has been led by lengthy study of friction of nominally unlubricated and semi-lubricated bodies.

FUELS. See COAL; OIL FUEL; PULVERIZED COAL.

FURNACES, ANNEALING

Tunnel. Unusual Tunnel Annealing Furnace. Iron Age, vol. 117, no. 20, May 20, 1926, pp. 1410–1413, 7 figs. Car-type continuous kiln 210 ft. long, in operation at plant of Northwestern Malleable Iron Co., Milwaukee, anneals 28 tons per day; runs on 120-hour cycle.

FURNACES, HEATING

Regenerative. Siemens Regenerative Ingot-Heating Furnace with Blast-Furnace-Gas Firing (Siemens-Regenerative-Stossofen mit Hochfengas-Feuerung und Flammenteilung), A. Sprenger. Stahl u. Eisen, vol. 46, no. 11, Mar. 18, 1926, pp. 361–368, 8 figs. Describes furnace with new type of sliding rails and satisfactory results obtained under prolonged operation; important feature is erection of furnace at considerable distance from rolling mill in a special building; other features are waste-heat utilization, arrangement of sliding rails, etc.

G

GAGES

Optical Instruments for. See OPTICAL INSTRUMENTS.

GAS PRODUCERS

Operation. Operation of Gas Producers, F. S. Bloom. Fuels & Furnaces, vol. 4, no. 4, Apr. 1926, pp. 451–452 and 458, 5 figs. Design and operation of jet blowers and turbo-blowers.

GAS TURBINES

Advantages and Limitations. Gas and Oil Turbines (Turbine à gaz et à pétrole), J. Deschamps. Technique Moderne, vol. 18, nos. 5 and 6, Mar. 1 and 15, 1926, pp. 152–153 and 182–183. Author, who has studied problems of gas and oil turbines during period of 20 years, states briefly their advantages and limitations; shows that compressor exercises controlling influence over net efficiency and practical prospects of gas turbine, and offers correlated suggestions which should be helpful to designers; gas turbine shows to best advantage when using rich gas, and oil turbine offers important advantage that only air has to be compressed; it is estimated that weight and space occupied by complete gas-turbine plant would be not more than one-quarter the figures for reciprocating gas engine, while efficiency would be much higher than that of steam turbines and boiler plant. See also translated abstract in Power Engineer, vol. 21, no. 242, May 1926, p. 193.

GEARS

Hob-Measuring Machines. Recent Developments at the National Physical Laboratory. Machy. (Lond.), vol. 28, no. 708, Apr. 22, 1926, pp. 111–113, 3 figs. Special machine for hobs; pantograph platform; micrometer for moving pantograph; simplified design.

Hypoid. The Design and Manufacture of Hypoid Gears, A. L. Stewart and E. Wildhaber. Am. Mach., vol. 64, no. 22, June 3, 1926, pp. 857–862, 8 figs. Offset axes of hypoid gears produce combined rolling and endwise sliding action; new method of production permits mathematically accurate tooth forms to be made at low cost. Paper presented before Soc. Automotive Engrs.

Instrument. Die and Assembling Fixture for Instrument Gears, H. M. Groff. Machy. (N. Y.), vol. 32, no. 9, May 1926, pp. 726–729, 6 figs. Split arbor for holding blanks; die for piercing arbor hole; design of die punch member; assembling fixture.

Tooth Standardization. Standardization of Gear Teeth (Ueber die Normung der Zahnform), Bauersfeld. Maschinenbau, vol. 5, no. 6, Mar. 18, 1926, pp. 258–262, 3 figs. Criticisms of proposed German standards and changes suggested; also attitude of American Gear Committee toward German proposals.

GLUES

Polishing, for. The Use and Treatment of Glue for Polishing, B. H. Divine. Automotive Mfr., vol. 67, no. 12, Mar. 1926, pp. 22–24. Kinds of glue used in polishing; application, ventilation and heating, drying and setting.

GOVERNORS

Hydroelectric Units. Governors for Automatic Hydro-Electric Units, J. F. Spease. Gen. Elec. Rev., vol. 29, no. 5, May 1926, pp. 356–359, 2 figs. Automatic operation requires governor accessories; starting solenoid; accelerating oil dashpot; gate-locking device; actions under various service conditions.

GRAPHITE

Lubrication Tests. The Role of Graphite in Lubrication, F. L. Koethen. Ind. Eng. Chem., vol. 18, no. 5, May 1926, pp. 497–499, 5 figs. Tests on Riehle machine to determine amount of pressure required to rupture fluid films in 3-in. bearing rotating at constant speed, and measurements of coefficients of friction of weighted sliders, in each case using oil with and without suspended graphite; results show that under conditions of ruptured film lubrication with some solid-to-solid contact, presence of graphite substantially reduced friction.

GRINDING

Locomotive Parts. Grinding of Locomotive Parts, K. H. Lansing. Abrasive Industry, vol. 7, no. 5, May 1926, pp. 149–150, 4 figs. Grinding machines are replacing planers and millers; valve motion work expedited quickly; internal grinding refits air-brake units.

H

HAMMERS

Pneumatic. Steam and Compressed-Air Hammers (Damp- og Lufthamre), F. Johansen. Ingeniören, vol. 35, no. 5, Jan. 30, 1926, pp. 37–46, 16 figs. Calculation of work from weight, velocity, and height of fall; design of steam hammers for swaging; pneumatic hammers and comparative test data showing saving effected by latter.

HARDNESS

Testers. The Firth Hardometer. Machy. (Lond.), vol. 28, no. 706, Apr. 8, 1926, pp. 51–52, 6 figs. Hardness-testing apparatus placed on market by T. Firth & Sons, Sheffield, Eng., which covers all ordinary testing requirements at reasonable cost; it will test hardness of medium and hard steels down to 1 mm. in thickness and soft steels and non-ferrous metals down to 2 mm.

HEAT TRANSMISSION

Heat-Conduction Coefficients. The Role of Heat Transmission and Despretz's Heat-Conduction Coefficients (Die Rolle des Wärmeübergangs beim Vergleich von Wärmeleitzahlen nach Despretz), M. Jacob and S. Erk. Zeit. für Physik, vol. 35, no. 8–9, Feb. 4, 1926, pp. 670–682, 4 figs. Points out that Despretz method gives incorrect relative values of heat conductivity, if relation of heat transmission to difference in temperature between experimental bar and air is disregarded; shows how method can be simplified.

Nature of. What We Know Today of the Nature of Heat Transmission (Was wir heute über die Natur des Wärmeübergangs wissen), Lent. Wärme, vol. 49, no. 9, Feb. 26, 1926, pp. 145–149, 5 figs.; also translation in Mech. Eng., vol. 48, no. 6, June 1926, pp. 610–612, 4 figs. Author attempts to present survey of present knowledge concerning flow of heat, by expressing fundamental exceptions governing this phenomenon rather than attempting to give actual numerical values or formulas; individual processes exerting influence on heat transmission; heat transmission by conduction and convection; considers case of totally enclosed room and imagines it to be filled with CO_2; tests give confirmation to claim that so-called invisible flames do not "work" an open-hearth bath, but that they begin to work it when inocculated properly with carbon.

HEATING, ELECTRIC

Water. The Heating of Water by Electricity for Domestic Purposes, S. Parker-Smith and N. M. Macelwee. World Power, vol. 5, no. 26, Feb. 1926, pp. 78–89, 17 figs. Results of tests carried out at Royal Technical College, Glasgow, in order to ascertain suitable heat-insulating materials for domestic hot-water tanks, and to determine thickness of such materials required.

HEATING, HOT-AIR

Houses. Warm Air Furnace Heating, A. W. Lordahl. Am. Gas Jl., vol. 124, no. 15, Apr. 10, 1926, pp. 310–312. Installation and location of furnace; importance of proper humidity. Paper read before Industrial Gas Assn. of New England.

HEATING, HOUSE

Hot-Air. The Practical Side of Warm Air House Heating, O. J. Kuenhold. Gas Age-Rec., vol. 57, no. 15, Apr. 10, 1926, pp. 505–506, 538 and 540. How to quickly calculate heating requirements in homes and how to find cost of heating homes with gas in warm-air systems.

HEATING, STEAM

Central. Heat Transmission in Central Heating Plants (Die Wärmefortleitung bei Fernheizkraftwerken), M. Maurer. Siemens-Zeit., vol. 6, no. 1, Jan. 1926, pp. 29–36, 8 figs. Discusses in detail hot-water and steam-heating systems, calculation of heat required, losses in transmission due to cooling, etc.; bleeder turbines, overall efficiency; characteristics of each type.

Rapid Development shown in Central Heating. Power Plant Eng., vol. 30, no. 10, May 15, 1926, pp. 611–612. Heating supplied from block and district plants is meeting favor in business and industrial districts.

HOBBING MACHINES

Automatic Gear. Gear Hobbers Equipped with Hydraulic Table Load Balancing Device. Iron Age, vol. 117, no. 15, Apr. 15, 1926, p. 1063, 2 figs. Machine manufactured by H. Pfauter Wks., Chemnitz, Germany, include hydraulic-table load-balancing device.

HYDRAULIC TURBINES

Cavitation. Turbines and the Cavitation Problem, E. Englesson. Can. Engr., vol. 50, no. 15, Apr. 13, 1926, pp. 471–474, 6 figs. With particular reference to Kaplan and propeller turbines; cause and effect of cavitation and its serious consequences; conclusions arrived at by Committee of British Admiralty; factors affecting cavitation limit; cavitation laboratory at Verkstaden; experiments with oscilloscope.

Characteristics. Characteristics of Hydraulic Turbines and the Choice of a Turbine (Des caractéristiques des turbines hydrauliques pour groupes electrogènes et du choix de ces machines), G. Routin. Société Française des Electriciens—Bul., vol. 6, no. 53, Jan. 1926, pp. 33–44, 1 fig. In considering type of turbine that is suitable for any installation it is usual to rely on specific speed, selecting that type whose efficiency is greatest at desired specific speed; examination of losses and efficiency of set of geometrically similar turbines shows that latter is function of a given characteristic based on r.p.m., volume of water used per sec., and head, and not of specific speed.

Governors. New Acceleration Governor by Escher Wyss & Co. (Nouveau regulateur "à accélération" de la Société Escher Wyss & Co.), Bul. Technique de la Suisse Romande, vol. 52, no. 5, Feb. 27, 1926, pp. 50–53, 3 figs. Design and operation of Gagg regulator, assuring very smooth running of servo-motors.

High-Speed. Recent Developments in Hydraulic Turbines, F. Johnstone-Taylor. Elec. Times, vol. 69, no. 1799, Apr. 8, 1926, pp. 452–453, 4 figs. Refers to type introduced by T. Bell & Co., Kriens, Switzerland; high speeds on low falls.

Ice and Trash Removal. Removal of Ice and Trash in Vertical Turbine Installations. Power, vol. 63, no. 19, May 11, 1926, p. 705, 1 fig. Design, patented by R. Koechlin, Switzerland, tends to be well adapted to large flow and low head, and permits removal of ice and floating bodies over entire length of building without obstructing turbines and without requiring supplementary canals or lengthening turbine room.

Kaplan. Economic Use of Water Power for Generating Electricity with Special Reference to Water Storage and Field of Application of Kaplan Turbine (Ausnutzung der Wasserkräfte zur elektrischen Energieerzeugung mit Berücksichtigung der hydraulischen Speicherung und der Anwendungsmöglichkeiten der Kaplanturbine), W. Meyer. Elektrotechnischer Anzeiger, vol. 43, nos. 27 and 28, Apr. 3 and 7, 1926, pp. 321–327 and 333–335. Discusses load variation, allocating basic loads to water power and peak loads to steam auxiliaries or storage batteries; high-speed turbine operation; various types of arrangement of Kaplan turbines and regulators; power plants using Kaplan turbines; comparison with Lawaczeck turbines.

Regulation. Regulation of High-Speed Hydraulic Turbines, J. S. Carpenter. Power, vol. 63, no. 20, May 18, 1926, pp. 783–784, 2 figs. How operating characteristics of high-speed turbine differ from those of moderate-speed machine and how this affects speed regulation of unit; how to calculate speed regulation.

Sweden. The Biggest Water Turbines in the World. Swedish Export, vol. 10, no. 4, Apr. 1926, pp. 40–41, 3 figs. Turbines installed in hydroelectric station at Lilla-Edet are of vertical type and of 10,000-hp. capacity; 2 were built by Finshyttan Works and are of Lavaczeck type; runners are 19 ft., 7½ in. in diameter; third turbine built by Verkstaden in Kristinehamn represents new departure in hydroelectric-turbine construction; advantages claimed for Kaplan.

HYDROELECTRIC DEVELOPMENTS

Georgia. The Bartlett's Ferry Hydroelectric Development, H. A. Hageman and T. B. Parker. Boston Soc. Civ. Engrs.—Jl., vol. 13, no. 3, Mar. 1926, pp. 93–125, 15 figs. Engineering and construction features of hydroelectric stations at Chattahoochee River, operated by Columbus Electric & Power Co.; in planning development principal consideration was given to analysis of stream-flow records above site; type, location and design of structures required; selection of hydroelectric machinery and appurtenances; construction equipment and its arrangement.

Ontario. Developments of the Hydro-Electric Power Commission of Ontario, F. A. Gadby. Am. Soc. Civ. Engrs.—Proc., vol. 52, no. 5, May 1926, pp. 911–941, 12 figs. Describes power developments of Commission; administration; sources of power supply; systems operated and plants constructed by Commission; Queenston-Chippawa development; Nipigon River development; Central Ontario system.

HYDROELECTRIC PLANTS

Operating Schedules. Operating Schedules and Their Use in Hydro-Electric Plants, P. F. Kruse. Power, vol. 63, no. 15, Apr. 13, 1926, pp. 561–564, 5 figs. Methods employed in working out operating schedule that has been adopted in large hydroelectric plant; this schedule has been applied to good advantage in operation of station.

Reconstruction. Reconstructing a Hydro-Electric Station, W. Brenton. Elec. Light & Power, vol. 4, no. 5, May 1926, pp. 100–103 and 105, 5 figs. Reconstruction of plant at Oregon City, Ore., located by falls of Willamette; first electrical development at falls, which was also first hydroelectrical development in United States, took place in 1889; original units have been replaced with 1000-kw. units having single turbine utilizing old settings.

South Carolina. The Catawba Hydro-Electric Plant of the Southern Power Company. Power, vol. 63, no. 19, May 11, 1926, pp. 700–702, 5 figs. New Catawba plant of 75,000-kva. capacity replaces former 10,000-kva. plant; new dam increases head from 25 to 70 ft.

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ICE PLANTS

Diesel-Engined. Diesel Engine Driven Ice Plants, E. Michel. Power House, vol. 19, no. 7, Apr. 5, 1926, pp. 21–22, 3 figs. Economic advantages of Diesel-engine drive.

Orange-Car Icing Plant. New Refrigerating Plant to Ice Florida Orange Cars. Power, vol. 63, no. 17, Apr. 27, 1926, pp. 635–637, 6 figs. Federal Ice Refrigerating Co. installs electrically driven ice plant of 500-ton capacity at Sanford, Fla.; compressors are of horizontal double-acting type; simplified piping system; plant is completely motorized.

INDUSTRIAL MANAGEMENT

Automotive Industry. What Executives Can Learn from the Automotive Industry, J. B. Webb. Indus. Mgmt. (N. Y.), vol. 71, nos. 2, 3, 4 and 5, Feb., Mar., Apr. and May, 1926, pp. 65–69, 151–156, 230–234, and 298–301, 30 figs. Author seeks to show how achievements in automotive industry were accomplished, to lay bare principles involved, and show how they can be applied to other industries with widely varying problems. Feb.: Inception of mechanical pace-making. Mar.: Overhead conveying system, as applied to progressive manufacture. Apr.: Wide adaptability of conveyorized production. May: Types and forms of conveyors.

Basic Principles. Fundamental Principles of Scientific Management (Grundsätze der Betriebswissenschaft), F. Meyenberg. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 17, Apr. 24, 1926, pp. 553–555. Points out that scientific management involves dealing with materials and men, as well as plants, machinery, materials-handling equipment, etc., and organization methods, such as standardization, continuity of production, and finally, control of these measures by cost accounting.

Budgetary Control. Major Results of Budgetary Control, W. S. Clithero. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 343–346. System employed by Armour & Co. has helped to coördinate all activities, forestalled losses, made for consultation and agreement before action, and aided in reducing costs and expenses.

Business Forecasting. Scientific Business Forecasting, J. L. Stone and S. L. Kederski. Taylor Soc.—Bul., vol. 11, no. 2, Apr. 1926, pp. 52–61, 6 figs. Methods used by Philadelphia concern and resulting benefits.

Departmental Management. Putting Responsibility Up to Each Department, F. H. Colvin. Am. Mach., vol. 64, no. 14, Apr. 8, 1926, pp. 543–545, 4 figs. Method of management whereby each manufacturing department is run as separate shop that sells its product to assembling department for final sale.

Executive Control. The Technic of Executive Control in Shop Management, W. Clark. Soc. Indus. Engrs. Bul., vol. 8, no. 3, Mar. 1926, pp. 11–17. Methods used by writer; deals with plant layout, storekeeping, inspection, planning, motion study and rate setting, and cost keeping; technique of getting action.

Financial and Industrial Investigation. Operating and Balance Sheet Ratios, A. Andersen. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 351–354. Ratios as indices to operations; types and significance of ratios; temporary financing for fluctuations; ratio of net worth to total capital employed; eliminating influence of depreciation; ratio of stock equities to net worth; importance of earned surplus.

General Administration. Trends in General Administration, J. O. McKinsey. Taylor Soc.—Bul., vol. 11, no. 2, Apr. 1926, pp. 79–80. Enumeration of trends as seen by specialist in budgetary control.

Improved Methods. Improved Methods Double Production, C. F. O'Connor. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 369–371, 2 figs. Universal Winding Co. increases output per employee 100 per cent by good management and wage incentives.

Improved Working Conditions. Improved Working Conditions in the Factory (Der Mensch in der Fabrik), E. Sachsenberg. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 17, Apr. 24, 1926, pp. 556–562, 28 figs. Numerous examples are cited to illustrate obstructions which delay work in factories; author suggests ways and means of overcoming these hindrances, mainly through psychological influences of various kinds which are intended to be of aid to personnel.

Inventory Control. The Control of Inventory Through the Scientific Determination of Lot Sizes, H. S. Owen. Indus. Mgmt. (N. Y.), vol. 71, no. 5, May 1926, pp. 306–310, 6 figs. Scheduling and controlling parts through manufacturing processes.

Manufacture and Sales Coördination. Balancing Manufacturing and Distribution, H. S. Dennison. Taylor Soc.—Bul., vol. 11, no. 2, Apr. 1926, pp. 81–82. How merchandising managers coördinate factory and sales departments.

Manufacturing Design and Production. Influence of Design on Production, E. Buckingham. Mech. Eng., vol. 48, no. 5, May 1926, pp. 442–444. Purposes manufacturing design has to fulfill; essential features of component drawings; rules for dimensioning drawings; selection of manufacturing processes; refinement and improvement of production methods.

Motion Study. See MOTION STUDY.

Order Filling. Short Cuts to Accurate Order-Filling, J. G. Aldrich. Mfg. Industries, vol. 11, no. 5, pp. 335–336. System adopted by New England Butt Co., manufacturers of braiding, cabling and other types of machines for handling and final filing of orders.

Production Incentives. Production Incentives at the Curtis Publishing Company, W. D. Fuller. Taylor Soc.—Bul., vol. 11, no. 2, Apr. 1926, pp. 80–81. Requirements of economy-sharing plan and system employed.

Sales Program. The First Step in a Market Survey, H. L. Keely. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 355–358, 1 fig. Practical methods to determine what, where, whom and how of manufacturer's sales program.

Small Factories. Capitalizing the Advantages of the Small Factory, D. S. Cole. Indus. Mgmt. (N. Y.), vol. 71, no. 5, May 1926, pp. 311–316. Fostering good will as permanent asset; definition of "good will."

Time Study. See TIME STUDY.

Waste Elimination. See WASTE ELIMINATION.

INDUSTRIAL PLANTS

Labor-Saving Equipment. Labor-Saving Equipment Feature New Westinghouse Air Brake Plant, G. W. Wildin. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 337–342, 9 figs. Layout of building; foundry and machine shop and their equipment.

INDUSTRIAL RELATIONS

Railways. Personnel Activities of the Delaware and Hudson Railroad, W. W. Bates. Taylor Soc.—Bul., vol. 11, no. 2, Apr. 1926, pp. 62–67. Board of disciplining officers; personnel records; labor turnover; educational and social activities; group and unemployment insurance.

INSULATION, HEAT

Economical Thickness. Choosing Economical Thickness of Heat Insulation, L. E. Whitaker. Power, vol. 63, no. 20, May 18, 1926, pp. 762–766, 8 figs. Presents charts which supply rational and easily workable basis for choosing most economical thickness of heat insulation for any given set of conditions.

Refrigerating Plants. Calculation of Insulation in Refrigerating plants (Die Bemessung von Kälteschutzmitteln), I. S. Cammerer. Zeit. für die gesamte Kälte-Industrie, vol. 33, nos. 3 and 4, Mar. and Apr. 1926, pp. 34–38 and 52–56, 9 figs. Discusses insulation of refrigerating equipment from technical and economic standpoints; minimum thickness of insulation to avoid precipitation of moisture at surface of insulation.

INTERNAL-COMBUSTION ENGINES

Friction Losses. Friction Losses in Explosion Engines (Pertes par frottement dans les moteurs à explosion), Champsaur. Technique Automobile et Aérienne, vol. 17, no. 132, 1926, pp. 1–8, 6 figs. Discusses viscosity of lubricant as factor in friction losses; force, coefficient and heat of friction, calculation of friction losses for various engine parts; exact calculation of quantity of heat transmitted by oil, and its variation with type of engine.

Ignition. High-Tension Ignition for Internal-Combustion Engines (Die Hochspannungszündung für Verbrennungsmotoren und neue Wege ihrer Entwicklung), H. Pickerott. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 17, no. 4, Feb. 27, 1926, pp. 73–77, 5 figs. Author shows that, by introduction of new working principle based principally on use of an electric contact breaker, coil ignition compares favorably with magneto ignition; shows also that, with both coil and magneto ignition, a number of defects can be traced to arc components of ignition spark; elimination of arc can best be effected by use of Lepel current transformer.

Jacket Water for. Jacket Water for Internal-

Combustion Engines. Power Engr., vol. 21, no. 241, Apr. 1926, pp. 134–135, 2 figs. Considers important points in connection with cooling water for gas and oil engines.

Supercharging. Mixing and Ignition in Supercharged Engines. Nat. Advisory Committee for Aeronautics—Tech. Memorandums, no. 360, Apr. 1926, 26 pp., 19 figs. For carburetor engines which work with preliminary compression of charging mixture, there are 2 principal methods of mixing, with suction carburetor and pressure carburetor; effect of current transformer on process of discharging; advantage of current transformer. Translated from Motorwagen, Dec. 10, 1925. See reference to original article in Engineering Index 1925, p. 46.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON CASTINGS

Defects. Causes of Defective Casting. Iron Age, vol. 117, no. 19, May 13, 1926, p. 1349, 1 fig. Interstate Commerce Commission report by physicist points out physical errors in truck frame that led to railroad wreck.

Machinability. Factors Affecting Machinability of Castings (Facteurs influençant l'usinabilité de la fonte), Fonderie Moderne, vol. 20, Mar. 1926, pp. 72–75, 10 figs. Discusses presence of carbon in form of graphite and its abrasive effect on cutting tools; explains this abrasion by micrographic study of structure of castings.

L

LABORATORIES

Hydraulic. New Testing Laboratory (La nuova Sala Sperimentale delle "Construzioni Meccaniche Riva"), F. Marzolo. Energia Elettrica, vol. 3, no. 2, Feb. 1926, pp. 93–103, 25 figs. Layout and equipment of laboratory for testing hydraulic turbines and centrifugal pumps operating since 1921 by private company.

LATHES

Arbor for Holding Gear Blanks. Lathe Arbor for Holding Gear Blanks, R. Mawson. Machy. (N. Y.), vol. 32, no. 9, May 1926, p. 717, 1 fig. Arbor was designed primarily for machining gear blanks from solid steel forgings.

Turret. Cutting Turret Lathe Time on the Part. Can. Machy., vol. 35, no. 14, Apr. 8, 1926, pp. 16–17. Precautions necessary to secure accuracy, when roller steady rests are employed; advantages and application of combination cutting to manufacture of parts.

Gisholt Turret Lathes. Machy. (N. Y.), vol. 32, no. 9, May 1926, pp. 745–747, 4 figs. New line of heavy ball-bearing lathes placed on market by Gisholt Machine Co., Madison, Wis. See also description in Am. Mach., vol. 64, no. 17, Apr. 29, 1926, pp. 687–689, 4 figs.

LIGHTING

Factories and Schools. Report of L. B. Marks, Chairman of Committee on Lighting of Factories and Schools, International Commission on Illumination. Illum. Eng. Soc.—Trans., vol. 21, no. 4, Apr. 1926, pp. 402–408. Report presented before Int. Commission on Illumination held at Geneva, Switzerland, July, 1924, giving brief summary in connection with preparation and adoption of industrial and school lighting codes in United States.

LIQUIDS

Heat Convection in. Heat Convection (Beiträge zur Frage der Wärmekonvektion), B. Gündel. Annalen der Physik, vol. 78, no. 8, Jan. 1926, pp. 697–742, 6 figs. Discusses stationary liquid streams which come under influence of gravity acceleration due to inconstancy of mass density brought about by a certain temperature distribution; in these streams heat conduction and convective heat transfer have simultaneous action due to mobility of liquid particles; this has made determination of heat conductivity of liquids more difficult than that of solids.

LOCOMOTIVES

Brake-Power Calculation. Calculating Brake Power of Locomotives, G. Norman. Machy. (Lond.), vol. 28, no. 707, Apr. 15, 1926, pp. 80–81, 2 figs. Author considers actual problem, viz., to design brake mechanism of 2-6-0 locomotive with 8-wheeled tender; giving engine-brake pressure equal to half the weight of engine in working order; tender vacuum-brake pressure being equal to one-half total weight of tender under like conditions.

Compound. Remarkable Four-Cylinder Compound Locomotives. Eng. Progress, vol. 7, no. 4, Apr. 1926, pp. 95–97, 6 figs. First German standard locomotive is express locomotive for Spanish Northern Railway; built by Hanomag, Hanover, Germany.

Electric. See ELECTRIC LOCOMOTIVES.

4-4-0. New 4-4-0 Locomotive, Southern Railway. Ry. Gaz., vol. 44, no. 16, Apr. 16, 1926, pp. 557–558, 3 figs. Development of design which has rendered good service since 1924, for duties which cannot be allocated to 4-6-0 locomotives.

Freight. Locomotives Built to Fit Traffic Needs. Ry. Rev., vol. 78, no. 19, May 8, 1926, pp. 827–829, 6 figs. New Mohawk locomotives develop rated tractive force of 60,600 lbs. without booster; total weight is 362,500 lbs.; boilers are of conical connected type.

Internal-Combustion. Gasoline-Driven Locotractors (Les locotracteurs à essence), M. Polart. Revue Générale des Chemins de Fer, vol. 45, no. 3, Mar. 1926, pp. 197–203, 4 figs. Design, equipment and operation of 100-hp. Baudet-Donon locomotive weighing 30 tons and pulling load of 500 tons at 15–18 km. per hr., used for switching and shuttle purposes between Paris stations of St. Lazare and Batignolles replacing steam locomotives.

Lignite-Burning. Million Dollar Saving in Fuel Consumption, M. A. Daly. Ry. Rev., vol. 78, no. 19, May 8, 1926, pp. 818–819, 2 figs. Northern Pacific cuts coal bill by converting locomotives to burn lignite from Rosebud fields.

Munich Show. Railway Rolling stock at the German Traffic Exposition, Munich 1925 (Die Eisenbahnfahrzeuge auf der Deutschen Verkehrsausstellung München 1925), W. Wetzler. Organ für die Fortschritte des Eisenbahnwesens, vol. 81, no. 5, Mar. 15, 1926, pp. 71–108, 62 figs. Details of design and equipment of non-electric rolling stock; steam locomotives for standard gage, Diesel and oil engines for motor cars, passenger cars, sleepers, inspection and training cars, snow plows, freight cars; narrow-gage equipment.

LUBRICATING OILS

Automobile Engines. Motor Carbon Deposits Formed under Controlled Conditions from Typical Automobile Oils, C. J. Livingstone, S. P. Marley, and W. A. Gruse. Ind. Eng. Chem., vol. 18, no. 5, May 1926, pp. 502–504, 3 figs. Small single-cylinder engine has been provided with special lubricating system, permitting circulation of small charge of lubricating oil, and with devices enabling operator to control very closely head, oil, and intake-air temperatures, amount of fuel and composition of fuel mixture, as well as load on engine and its speed.

Lubricating Values. Comparison of Lubricating Efficiencies of Oils and Some of Their Physical and Chemical Properties, M. V. Dover. Ind. Eng. Chem., vol. 18, no. 5, May 1926, pp. 499–501, 6 figs. Comparison of following properties of 3 mineral oils and 1 vegetable (olive) oil; iodine number, acid number, flash point, specific gravity, viscosity, surface tension interfacial and efficiency as lubricants; study of clogging effect of iron or steel capillaries by two of these oils.

Lubricating Value as Related to Certain Physical and Chemical Properties of Oils, L. W. Parsons and G. R. Taylor. Ind. Eng. Chem., vol. 18, no. 5, May 1926, pp. 493–496, 5 figs. Review of theory of lubrication and discussion of application to few special cases, with particular reference to value of certain tests.

Power and Viscosity. Power and the Viscosity of Oil, W. F. Parish. Ind. Eng. Chem., vol. 18, no. 5, May 1926, pp. 525–526, 2 figs. Quotes German authority, Holde, who claims that viscosity of oil is not only factor in determining lubricating power; oil should not lose its power of reducing friction by evaporation or by acting chemically on metal of bearing and should not contain drying oil; results of tests made in Germany.

Requirements and Properties. Lubricating Oils for Machinery (Ueber Maschinenschmieröle), Swoboda. Petroleum, vol. 22, no. 7, Mar. 1, 1926, pp. 247–253. Discusses conditions good oil should fill; animal, vegetable and mineral oils, and their properties; cylinder oils, simple and compound; specifications for oil for internal-combustion engines, steam turbines, etc.

Tests. Technical and Economic Factors in the Consumption of Lubricants (Fattori tecnici di economia nel consumo dei lubrificanti), V. Prever. Ingegneria, vol. 5, no. 1, Jan. 1926, pp. 15–22, 12 figs. States that insufficient attention is paid to consumption and testing; describes apparatus for testing lubricating capacity and other characteristics; theory of lubrication, etc.

Testing Lubricating Oils with Regard to Efficiency and Wear of Machines (Die Prüfung der Schmieröle im Hinblicke auf Leistung und Abnutzung der Maschinen), Spindel. Sparwirtschaft, nos. 2 and 3, Feb. and Mar. 1926, pp. B21–B25 and B43–B48, 8 figs. Tests carried out at Innsbruck Laboratory for Testing Materials to determine lubricating capacity; Spindel machine for testing wear, resistance to machining, etc.; characteristics and advantages of tests by Spindel system.

LUBRICATION

Factors Affecting. Some Little Understood Factors Affecting Lubrication, E. G. Gilson. Ind. Eng. Chem., vol. 18, no. 5, May 1926, pp. 467–470, 10 figs. Oil-film friction is shown to be influenced by change of one of metals between which film is working, and also by changing from oxidizing to monoxidizing atmosphere; demonstrates by means of complete bearing within enclosure how friction is affected by atmosphere surrounding bearing; points out that facts shown cannot be explained by viscosity-temperature changes of oil and suggests that efficient lubrication may be dependent upon reaction between metals of bearing and oil, nature of this reaction being influenced by atmosphere in which bearing is operating.

Fluid-Film. Surface Action and Fluid Film Lubrication, A. E. Becker. Ind. Eng. Chem., vol. 18, no. 5, May 1926, pp. 471–477, 17 figs. Author has devised apparatus for measuring film thickness developed; presents data for four oils and four bearing combinations.

Journal. Characteristics of Full and Partial Journal Bearings, H. A. S. Howarth. Ind. Eng. Chem., vol. 18, no. 5, May 1926, pp. 453–460, 18 figs. Analysis is applied to bearings bored with running clearance and bearings fitted carefully to journal; these types have been studied graphically to provide complete and thorough set of fundamental laws which must govern actual lubrication of all plain journal bearings. Paper, except parts on total friction in full bearings and viscosity-temperature conversion chart, is résumé of 3 contributions by author to Am. Soc. Mech. Engrs. in 1923, 1924, and 1925.

Oiliness in. The Role of Oiliness in Industrial Lubrication, W. C. Wilharm. Ind. Eng. Chem., vol. 18, no. 5, May 1926, pp. 463–467, 3 figs. Outlines importance of efficient lubrication and discusses mechanism and possibilities for improving vital factor as it especially applies to electrical machinery and such other types as are not subjected to high temperatures; analysis of results shows difference in lubricating value of various lubricants that is not shown in tests usually made and throws more light on mechanism of property of oiliness.

Problems. Lubrication, S. E. Bowrey. Inst. Mar. Engrs.—Trans., vol. 37, Mar. 1926, pp. 751–762 and (discussion) 763–775. Outlines resources at disposal of manufacturers and methods for preparing lubricants in general use; behavior of lubricants and theory of lubrication; oil testing.

Protecting Bearings from Dust. The Relation of Clean Air to Efficient Lubrication, A. F. Brewer. Indus. Mgmt. (N. Y.), vol. 71, no. 5, May 1926, pp. 284–289, 11 figs. Notes on guarding bearing surfaces not only against their own friction but against contamination of dust-laden and grit-laden air.

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MACHINE SHOPS

Germany. Workshops of the German Machine-Tool Industry (Die Arbeitsstätten des deutschen Werkzeugmaschinenbaues), G. Schlesinger. Werkstattstechnik, vol. 20, no. 5, Mar. 1, 1926, pp. 129–175, 162 figs. Reviews development of industry and describes activities and products of numerous firms in heavy machine-tool line, medium and small-tool line, and various special lines like lathes, drilling plants, automatic tools, etc.

Standards of Performance. Standards of Performance in Shop Work, J. S. Gray. Machy. (N. Y.), vol. 32, no. 9, May 1926, pp. 724–725. Standard time is shortest possible time in which work can be done; by having standard with which comparisons can be made, estimated cost can be compared with actual cost of all work being performed.

MACHINE TOOLS

Honing Machines. Barnes Hydraulically Reciprocated Honing Machines, Types Nos. 214 and 212. Am. Mach., vol. 64, no. 21, May 27, 1926, pp. 837–838, 2 figs. Developed by Barnes Drill Co., Rockford, Ill., especially for automotive production.

Individual Drive. Individual Drive for Small Machine Tools (Wirtschaftlichkeit des Einzelantriebes kleinerer Werkzeugmaschinen), H. v. Neuenkirchen. Maschinenbau, vol. 5, no. 7, Apr. 1, 1926, pp. 300–306, 8 figs. Comparison between group and individual drives; economics of electric drive; concludes that efficiency and cost are in favor of individual drive in almost all cases of practical operation.

Research and Practical Application. Machine Tools and Tools (Werkzeugmaschinen und Werkzeuge), E. h. J. Reindl. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 17, Apr. 24, 1926, pp. 536–568, 28 figs. Research on cutting speed, chip section and shape of tool and application of results in the workshop; rapid change of tool and workpiece; application of special machines; further extension of standardization as basis for specialization.

MACHINERY

Sizing and Overload. The Demand for Overload in the United States, C. F. Hirshfeld. Power, vol. 63, no. 17, Apr. 27, 1926, pp. 632–634, 1 fig. Discusses theory of sizing machines of all types from general point of view; points out that designation of size of machine is easily confused with statement of its capacity which really depends upon both size and conditions of application; advocates designating sizes by letters or other symbols not implying performance, with data furnished for determining capacity for any stated operating conditions; if this were done, term "overload" would cease to be used in many instances. (Abstract.) Paper read before New York Mtg. Int. Electrotech. Commission.

MAGNESIUM ALLOYS

Physical Properties. Physical Properties of Very Light Magnesium Alloys (Sur quelques propriétés physiques des alliages de magnésium ultra-légers), A. Portevin and F. Le Chatelier. Académie des Sciences—Comptes Rendus, vol. 182, no. 6, Feb. 8, 1926, pp. 382–384. Presents formulas which express specific volume; gives values for aluminum and zinc representing limiting solid solution and limit of homogeneity; coefficient of expansion is in no case greatly different from that of magnesium; zinc and lead cause increase whereas copper, nickel, and especially silicon cause decrease; taking mechanical properties into account, it is concluded that binary magnesium alloys with nickel and copper, and ternary alloys with aluminum-nickel and aluminum-copper promise to be most useful; for applications, such as pistons, they give most suitable values for density, elastic limit, hardness, heat conductivity, and expansion.

MALLEABLE CASTINGS

Heat Treatment and Quenching. Avoids Embrittlement in Malleable Iron Castings, E. Bremer. Iron Trade Rev., vol. 78, no. 15, 1926, pp. 992–994 and 998, 6 figs. New process of heat treatment and quenching in use at Ohio Brass Co., Mansfield, O., removes galvanizing difficulties and aids machining; loss of product reduced materially.

MALLEABLE IRON

Direct Production. Production of Malleable Iron Direct from Iron Ore, Dispensing with the Blast Fur-

nace. Machy. Market, no. 1328, Apr. 16, 1926, pp. 19–20. Describes 3 solutions of problem, Flodin, Wiberg and Emil Edwin. Translated from Svenska Bruk.

MANOMETERS

Calibration. A Simple Method for Calibrating Micromanometers (Ein einfaches Verfahren zur Eichung von Mikromanometern), F. Levy. Zeit. für Instrumentenkunde, vol. 45, no. 11, Nov. 1925, pp. 515–530, 6 figs. A U-tube from manometer, and U-tube for introduction of air are arranged to give access to air enclosed in miniature diving bell; weight of this bell in position of atmospheric pressure inside is balanced, and weights are then added to bell, and air is introduced to give any desired internal pressure; this internal pressure can be calculated accurately from dimensions, and compared with reading of manometer.

MATERIALS HANDLING

Factories. Materials Handling in Plants Manufacturing Diversified Products (Das Förderwesen in Betrieben mit stark wechselnder Fertigung), H. D. Brasch. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 17, Apr. 24, 1926, pp. 573–578, 13 figs. Arrangement and regulation of materials-handling system; equipment and methods; organization and control of system; safety measures.

Safety in. Safety in Materials Handling, D. S. Beyer. Mech. Eng., vol. 48, no. 5, May 1926, pp. 475–480, 5 figs. Analysis of accident hazards in general broad classifications, and methods of prevention; author calls attention of engineers to necessity of including in construction drawings and specifications means for prevention of such accidents.

METALLOGRAPHY

Microscopic Examination of Metals. The Optical Examination of Metals, G. Sachs. Metal Industry (Lond.), vol. 28, no. 15, Apr. 9, 1926, pp. 341–343, 6 figs. Methods of lighting; images obtained; types of illuminator; inverted microscope; macrophotography.

METALS

Research. The Present Status of Metal Research [Der heutige Stand der Werkstoff-(Metall-)Forschung], F. Körber. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 15, Apr. 10, 1926, pp. 491–496, 21 figs. Purpose of material research; constitution of metals and alloys; microscopic examination of structure; X-ray examination; reactions in solid state; polymorphous transformations; properties of alloys; changes in properties of metals through permanent deformation; strain hardness; cold-deformation structure; recrystallization; importance of research of super-elastic deformations for mechanical testing, etc.

MILLING MACHINES

Fixtures. Milling Machines Handle Wide Range of Product. Am. Mach., vol. 64, no. 17, Apr. 29, 1926, pp. 675–678, 10 figs. Special fixtures and automatic controls feature new equipment; rigidity and ample supply of coolant favor heavy cuts and fast feeds.

Power Rapid Traverse. New Large Miller. Iron Age, vol. 117, no. 20, May 20, 1926, pp. 1431–1432, 2 figs. Power rapid traverse in 3 directions, Timken roller bearings, new coolant and lubricating pumps, etc. are features of new No. 4 milling machine brought out by Kearney & Trecker Corp., Milwaukee.

Universal. Universal Milling Machine with Two Overarms. Machy. (Lond.), vol. 28, no. 706, Apr. 8, 1926, p. 45, 1 fig. J. Parkinson & Son, Shipley, have introduced double overarms to their all-geared milling machines.

MOLDING MACHINES

Turnover-Type. Turnover-Type Molding Machine with Jarring Device in Turnover Top Table (Wendeplattenformmaschine mit Arbeitsrüttler in der Wendeplatte), A. Schwarze. Zeit. für die gesamte Giessereipraxis, vol. 47, no. 13, Mar. 28, 1926, pp. 142–143, 3 figs. Machine for quantity molding of larger castings, which produces molds by jarring and lifts or lowers these from table by means of rapidly working device, thus avoiding damage to flask in lifting it from table.

MOLDING METHODS

Car Wheels. Mechanical Molding of Car Wheels, R. F. Ringle. Can. Foundryman, vol. 17, no. 5, May 1926, pp. 22–23, 5 figs. Desire to cut costs provided incentive that enabled Brown Car Wheel Wks., Buffalo, N. Y., to overcome obstacles that previously had curtailed use of molding machines in car-wheel foundries; control is semi-automatic; truck delivers cores; it requires only 2 men to pour for entire foundry; maximum distance that hot castings are carried from time they are taken out of molds until they reach soaking pits does not exceed 15 ft.

Machine-Plate. Machine Plate Moulding Practice, J. Dean. Foundry Trade Jl., vol. 33, no. 506, Apr. 29, 1926, p. 336, 2 figs. Object of plate molding is to cheapen and increase output with accompanying greater uniformity and higher quality of work; describes application of "elastic" boxes and double pattern plate; advantages which can be obtained by use of multiple molding. (Abstract.)

Templet. Improved Templet Devices (Verbesserte Schabloniervorrichtungen), R. Löwer. Werkstattstechnik, vol. 20, no. 7, Apr. 1, 1926, pp. 221–223, 6 figs. Describes new types of templet devices for general and special purposes, which can also be used for production of conical molds.

MOLDS

Chill Roll. Making a Chill Roll Mould. Foundry Trade Jl., vol. 33, no. 503, Apr. 8, 1926, p. 268, 1 fig. Describes method employed in making chill-roll molds which is essential to build loam mold solid and strong to have mold warm at time of pouring and to use good class of pig iron.

Ramming. Modern Foundry Methods, F. A. McLean. Can. Foundryman, vol. 17, no. 4, Apr. 1926, p. 21. Molds rammed by hand cannot compare with those formed by hand-held pneumatic rammers, roll-over or jolt-ramming machines.

Modern Methods of Ramming Molds, R. Micks. Can. Foundryman, vol. 17, no. 4, Apr. 1926, pp. 11–12. Points out that advent of compressed air in foundry has done much towards increasing production and decreasing laborious work, and air or pneumatic rammer has proved a great boon to both foundryman and molder; making molds on squeezer; most recent method of ramming molds is with sandslinger.

MOTION STUDY

Economic Value. Reducing Costs 22% by Motion Study, J. A. Piacitelli. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 347–350, 7 figs. Considers features of cutting and packing of 10-in. strip shingles which is characteristic of majority.

MOTOR BUSES

Gasoline-Electric. Mack Departs from Usual Practice in Gas-Electric Design. Automotive Industries, vol. 54, no. 16, Apr. 22, 1926, p. 699, 1 fig. Uses single motor drive and retains standard rear axle and differential gear; two chassis sizes in production; designed for 25- and 29-passenger city-type bodies.

MOTOR TRUCKS

Cost Data. Operating Costs of Motor Trucks (Betriebskosten und Wirtschaftlichkeit von Lastkraftwagen), P. Friedmann. Allgemeine Automobil-Zeitung, vol. 27, no. 11, Mar. 13, 1926, pp. 17–19. Discusses conditions under which motor trucks of various types may be used to greatest advantage, and comparative operating costs of delivery cars; 2-ton and 5-ton trucks; trucks with trailers.

Electric. The Electric Motor Truck, D. M. Phillips. Elec. World, vol. 87, no. 17, Apr. 24, 1926, pp. 863–866, 3 figs. Characteristics and advantages of electric vehicles; their effect upon revenue of central-station companies; possibilities of development in proper fields of application. (Abstract.) Thesis presented to Univ. of Pennsylvania.

Reo. Reo Lowers Body, Improves Steering Gear of $1^1/_4$-Ton Truck. Automotive Industries, vol. 54, no. 16, Apr. 22, 1926, pp. 692–693, 1 fig. Steering made easier by use of intermediate gear in pinion and sector-type mechanism; hood lengthened, radiator changed to enhance appearance.

Six-Wheel. Special Six-Wheel Chassis Is Designed for Moving Vans. Automotive Industries, vol. 54, no. 18, May 6, 1926, p. 761, 2 figs. New job developed by Red Ball Corp. is built along bus lines and can be used for passenger transportation.

N

NON-FERROUS METALS

Standards. German Standards for Non-Ferrous Metals (Die deutschen Werkstoffnormend er Nichteisenmetalle), P. Melchoir. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 16, Apr. 17, 1926, pp. 529–535. Standardization is determined by German Industrial Standards Committee according to nature, properties, and designation; chemical and mechanical test standards; standards for nickel, aluminum, tin, zinc, copper, copper alloys, drawn metals, rods, pipe, wires, and plates.

O

OIL ENGINES

Heavy-Oil. A New Gardner Marine Heavy-Oil Engine. Mar. Engr. & Mortorship Bldr., vol. 49, no. 584, Apr. 1926, p. 129, 1 fig. Six-cylinder 300-b.hp. unit for propulsion of motor yacht Endymion; engines are directly reversible type and operate with crankcase scavenging on 2-stroke cycle.

An All-American Two-Stroke Cycle Double-Acting Heavy-Oil Engine. Mar. Engr. & Motorship Bldr., vol. 49, no. 585, May 1926, pp. 188–191, 7 figs. Four-cylinder, air-injection, 2900-b.hp. unit, built by Worthington Pump & Machinery Corp. of America to order of U. S. Shipping Board.

The Richardsons, Westgarth Heavy-Oil Engine. Mar. Engr. & Motorship Bldr., vol. 49, no. 585, May 1926, pp. 165–170, 19 figs. First 2-stroke-cycle double-acting unit, designed with low first cost and weight prominently in view, completed at Hartlepool Engine Works; airless fuel injection, on controlled pump system, and moderate compression pressures adopted.

High-Powered. High-Powered Oil Engines, W. S. Burn. North-East Coast Instn. Engrs. & Shipbldrs.—advance paper, for met., Apr. 23, 1926, pp. 325–352, 26 figs. partly on supp. plates; also (abstract) in Engineer, vol. 141, nos. 3670 and 3671, Apr. 30 and May 21, 1926, pp. 494–496 and 534–535, 12 figs. Details and performance of Richardsons-Westgarth double-acting 2-stroke engine with port scavenging, working with moderate compression pressure and employing solid-injection controlled-pump system of fuel injection; designed in endeavor to produce marine oil engine of high power per cylinder which would be low first cost and of simple construction; comparisons with other types as regards weight and space occupied and also between single- and double-acting oil-engine design.

Parsons. An Eight-cylinder Marine Oil Engine. Engineer, vol. 141, no. 3668, Apr. 16, 1926, p. 447, 1 fig. Designed for output of 56 b.hp. on paraffin fuel and 70 b.hp. when using gasoline, running at normal speed of from 900 to 950 r.p.m.

OIL FUEL

Burners. Oil Burner Service. Heat. & Vent. Mag., vol. 23, no. 4, Apr. 1926, pp. 80–81. Analysis, discussion and suggestions representing present practice.

Future Availability. Furnace Oil, Its Future Availability, R. L. Welch. Nat. Petroleum News, vol. 18, no. 15, Apr. 14, 1926, pp. 75–76. Discusses question of what petroleum resources will be available in future for house heating.

Heavy Oils. Experimental Investigation of the Physical Properties of Medium and Heavy Oils, Their Vaporization and Use in Explosion Engines, F. Heinlein. Nat. Advisory Committee for Aeronautics, no. 362, May 1926, 25 pp., 2 figs. Defines technically important physical properties of heavy oils, insofar as these properties affect vaporization under pressure and temperature conditions which exist during intake phase of engine; from results, conclusions will be drawn (with mathematical treatment of vaporization process of oils) on state of vaporization, as it takes place under conditions existing in engine. Translated from Motorwagen, Oct. 10, 1925.

Mazout for Diesel Locomotive. The Burning of Mazout in Diesel Engine of Russian Diesel-Electric Locomotive (Verbrennung von Masut im Dieselmotor der russischen dieselelektrischen Lokomotive), N. Dobrowolski. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 16, Apr. 17, 1926, pp. 527–528. Trial trips and their results show that Diesel locomotive operates as satisfactorily with mazout as with naphtha, and total efficiency of Diesel locomotive remains equally good.

Vapor Pressures. The Vapour Pressures of Fuel Mixtures, J. S. Lewis. Instn. Petroleum Technologists—Jl. vol. 12, no. 54, Feb. 1926, pp. 32–44 and (discussion) 44–47, 5 figs. Continuation of previous work, published in same journal (vol. 11, no. 49, 1925). Special attention is paid to influence of alcohol, utilization of which in fuel mixtures is more than theoretical possibility; addition of alcohol to hydrocarbons gives rise to mixtures of maximum vapor pressures or minimum boiling points.

OPTICAL INSTRUMENTS

Types. Measuring by Optical Means. Machy. (N. Y.), vol. 32, no. 9, May 1926, pp. 695–697, 6 figs. Applications of two optical instruments, developed by Bausch & Lomb Optical Co., Rochester, N. Y., intended for use in shop, tool-room and inspection department; one is a direct-reading thickness measure for accurate measurement to 0.0001 in.; other is toolmaker's microscope, applicable in connection with screw threads, gages, small jigs and other precision parts.

OXYACETYLENE WELDING.

Aluminum. Some Notes on the Welding of Aluminum, E. T. Painton. Mech. World, vol. 79, nos. 2049 and 2052, Apr. 9 and 30, 1926, pp. 290 and 341. Points out advantages of oxyacetylene welding; use of aluminum fluxes

Copper. Oxy-Acetylene Welding of Copper, S. W. Miller. Am. Welding Soc.—Jl., vol. 5, no. 3, Mar. 1926, pp. 23–31, 11 figs. Results of series of tests of copper welding rods containing deoxidizers such as silicon, manganese, aluminum, phosphorus and various combinations of them; results show that trouble with copper welding was due to reducing flame of welding blowpipe.

P

PACKING

Standardization. How Standardization Helps Export Packing Problems, R. W. Chalmers. Automotive Mfr., vol. 67, no. 12, Mar. 1926, pp. 13–15, 10 figs. Application of engineering principles and production methods to reduction of shipping work and costs; utilizing all space; importance on ocean vessels.

PATTERNMAKING

Shops. Pattern Shop Aids to Foundry Production, F. C. Edwards. Foundry Trade Jl., vol. 33, no. 505, Apr. 22, 1926, pp. 311–315, 15 figs. Notes on pattern reinforcement; pattern suitability for molding; cylindrical patterns; replacement of drawbacks by cores; balancing cores, etc.; eliminating mold repairing; oil-sand cores and economical production; importance of varnishing patterns; coloring of pattern parts.

PHOTOELASTICITY

Stress Analyses by. Some Recent Stress Analyses by Means of the Photoelastic Method, P. Heymans. Eng. Jl., vol. 9, no. 4, Apr. 1926, pp. 193–198, 9 figs. Historical survey of its development with some recent investigations carried on by this method. Bibliography.

PIPE, CAST-IRON

Centrifugally Cast. Centrifugal Pipe from Sand Molds. Iron Age, vol. 117, no. 15, Apr. 15, 1926, pp. 1055–1060, 12 figs. How sand-spun or mono-cast product is made in new plant of Am. Cast Iron Pipe Co.; details covering molds, sand and finished product; facing sand and handling flasks; photomicrographs of cast-iron pipe. See also description in Am. Gas Jl., vol. 124, no. 18, May 1, 1926, pp. 384, 388 and 390–391, 6 figs.; also Water Wks. Eng., vol. 79, no. 8, Apr. 15, 1926, pp. 444, 451 and 471, 10 figs.

PISTONS

Machining. Machining Pistons for the Automotive Industry. West. Machy. World, vol. 17, no. 4, Apr. 1926, pp. 145–148, 11 figs. Tool equipment

employed in engine department of Hall-Scott Motor Car Co., Berkeley, Cal., for manufacture of pistons at high rate of production.

Pins. Piston-Pin Methods That Are Different, F. H. Colvin. Am. Mach., vol. 64, no. 18, May 6, 1926, pp. 701–702, 5 figs. How Rickenbacker utilizes steel tubing for piston pins, and punches groove for binding bolt; grinding on mandrel with special backrest.

PNEUMATIC TOOLS

Mechanisms. Pneumatic Tool Mechanisms, F. Hills. Engineering, vol. 121, nos. 3145 and 3146, Apr. 9 and 16, 1926, pp. 462–463 and 507–508, 19 figs. Describes several machines of portable nature worked by compressed air, illustrating as far as possible mechanism and use of pneumatic tools.

POWER

Forecasting Regional Requirements. Predicting Regional Power Requirements, W. Alwyn-Schmidt. Power Plant Eng., vol. 30, no. 10, May 15, 1926, pp. 587–588. Methods of economic forecasting have developed sufficiently to be of aid in predicting future power requirements.

Generation, Developments in. Latest and Future Developments in Power Generation, L. C. Loewenstein. Franklin Inst.—Jl., vol. 201, no. 4, Apr. 1926, pp. 431–464, 30 figs. Study of problem of power production from engineering point of view; what has been accomplished; lines along which latest developments in power generation are progressing, and along which future endeavors should proceed.

Industry Balance Sheet. An Industry Balance Sheet. Elec. World, vol. 87, no. 19, May 8, 1926, pp. 971–982, 10 figs. Analysis of business situation in light and power industry, based on available data, opinion and general information; data show present business done in each class of service; gross income from each class and total investment in system capacity for each class of service and influence of different classes of business on total system characteristics, investments and revenues.

Purchased vs. Generated. Analyzing the Power-Purchase Problem, A. C. Wood. Power, vol. 63, no. 20, May 18, 1926, pp. 777–782, 6 figs. Factors affecting decision as to purchasing or generating power for industrial plants, particularly those requiring steam for heating and process purposes.

PRESSWORK

Tools. Examples of Press Tool Design for Typewriter Parts, W. E. Irish. Am. Mach., vol. 64, no. 21, May 27, 1926, pp. 825–829, 19 figs. Deals with diagrammatic layouts to indicate their construction and action; illustration of possibilities in finger-die design; channel-rolling machine.

PULVERIZED COAL

Ash from. The Ash from Powdered Fuel Installations, J. T. Dunn. Chem. & Industry, vol. 45, no. 11, Mar. 12, 1926, pp. 60T–61T. Examination of dust issuing from pulverized-fuel installations, and measurement of size of particles.

Burning Over Stokers. German Arrangement for Burning Pulverized Coal Over Stokers. Power, vol. 63, no. 23, June 8, 1926, p. 885, 4 figs. Special system for burning pulverized coal as supplementary fuel to increase output of stoker-fired boiler furnaces, which may be applied to plants that purchase pulverized coal delivered in special tank cars, or suitable unit mill may be also included for pulverizing raw coal and ashpit siftings on site; it is claimed that system is moderate in first cost and makes installation of additional or standby boiler equipment unnecessary.

Problems. Some Problems in the Use of Pulverized Coal, A. G. Christie. Power, vol. 63, no. 20, May 18, 1926, pp. 748–750. Suggestions for improving coal preparation and burning, presenting evidence that ash may aid combustion; author stresses importance of adequate instruments and need of simple means for checking loss of carbon in flue gas; advocates development of dust catchers.

Sampling. Sampling Pulverized Fuel (Richtlinien für die Probenahme von Brennstaub), K. Förderreuther. Glückauf, vol. 62, no. 11, Mar. 13, 1926, pp. 344–345. Detailed recommendations are made concerning procedure to be followed in order to obtain representative sample of pulverized fuel for testing. Rules prepared for Pulverized Coal Commission of the Reichskohlenrat.

PUMPING STATIONS

Electric. New Water Pumping and Filtration Plants, Hannibal, Mo., M. P. Hatcher. Eng. News-Rec., vol. 96, no. 18, May 6, 1926, pp. 727–728, 3 figs. Electrically driven pumps operated at night; water formerly coagulated, settled and chlorinated only.

Steam. An Efficient Waterworks Pumping Plant, H. R. Lupton. Engineer, vol. 141, no. 3668, Apr. 16, 1926, pp. 438–440, 2 figs. Results obtained in test of pumping plant supplied to Metropolitan Water Board for Lea Bridge pumping station; pumping engine is of triple-expansion inverted vertical type and its specified duty is to pump from 12,000,000 to 14,000,000 gal. of water per day against head of from 180 to 200 ft.; pumps are of outside packed ram type. (Abstract.) Paper read before Instn. Civ. Engrs. See also Engineering, vol. 121, no. 3147, Apr. 23, 1926, p. 528.

Equipment of Provincial Steam Plant of Bay of Friesland (De werktuigen ban het Probinciaal stoomgemaal voor den boezem van Friesland), J. C. Dijxhoorn. Ingenieur, vol. 40, no. 50, Dec. 12, 1925, pp. 1053–1065, 17 figs. Details of pumping plants near Zoutkamp and near Lemmer; boiler house of 6 compound boilers of 235 sq. m. surface; tandem-compound steam engines, 8 centrifugal pumps of 500 cu. m. capacity per minute driven in pairs by 4 steam engines.

PUMPS

Water Elevators. See WATER ELEVATORS.

PUMPS, CENTRIFUGAL

Turbine. Greensboro Water-Works Adds Turbine-Driven Pumps. Power, vol. 63, no. 18, May 4, 1926, pp. 681–682, 3 figs. Installation of 4,000,000- and 6,000,000-gal. series centrifugal pump built for 310-ft. head and driven by geared steam turbine.

R

RAILS

Heat Treatment. Heat Treatment of Rail Steel at the Works of Neuves-Maisons (La question de l'acier à rails et le traitement thermique des Usines de Neuves-Maisons), L. Thibaudier and H. Viteaux. Revue de Métallurgie, vol. 23, no. 2, Feb. 1926, pp. 65–81, 8 figs. Part I: Results of study made in collaboration with Alsace-Lorraine Railway show how difficult it is to meet simultaneously the two requirements of elastic limit and resilience in rails of carbon steel; heat treatment of street-railway rails. Part II: Method of heat treating carbon-steel rails at Neuves-Maisons by Compagnie des Forges de Châtillon, consisting essentially in intermittent tempering of head in a quantity of cold water determined in function of weight of bar to be treated; advantages of process, and results obtained.

RAILWAY MANAGEMENT

Budgeting. Stabilizing by Budget, C. D. Young. N. Y. Railroad Club—Official Proc., vol. 36, no. 5, Mar. 19, 1926, pp. 7954–7964, 8 figs. For service and control of railroad supplies; proposal for new functional group independent of operating and maintenance departments; possibilities in avoidance of waste.

RAILWAY MOTOR CARS

Diesel Electric. The New Diesel-Electric Motor Coaches on the Swiss Federal Railways. Brown Boveri Rev., vol. 13, no. 4, Apr. 1926, pp. 98–101, 5 figs. Details of car equipped with 250-b.hp. Diesel engine, power being electrically transmitted to driving axles.

German. New Internal-Combustion Motor Cars of the German State Railway (Die neuen Verbrennungstriebwagen der Deutschen Reichsbahn-Gesellschaft und ihre Versuchsergebnisse), Ebel. Organ für Fortschritte des Eisenbahnwesens, vol. 81, nos. 2 and 4, Jan. 30 and Feb. 28, 1926, pp. 19–23 and 55–58, 11 figs. Results of tests with cars equipped with 150-hp. Maybach engines, using crude oil; benzol motor cars of Deutsche Werke in Kiel, with 4-stroke 6-cylinder engines.

Operation and Lubrication. Operation, Maintenance and Lubrication of Motor Cars, W. E. Adams. Am. Ry. Assn. (Signal Section)—Proc., vol. 23, no. 4, Apr. 1926, pp. SC333–SC346. Study of existing types and their operation. See also article under same title by V. Pagett, discussing two-cycle engines.

RAILWAY OPERATION

Despatching System. Organization of Central Control Stations on Eastern Railways of France (Particularités de l'organisation des Postes Centraux de Régulation sur le réseau de l'Est), M. Massin. Revue Générale des Chemins de Fer, vol. 45, no. 4, Apr. 1926, pp. 247–259, 18 figs. Describes in detail apparatus and system adopted in 1919 and since perfected for train dispatching, which is giving satisfaction.

Train Control. The Automatic Train Control, C. S. Bushnell. Am. Ry. Assn. (Signal Section)—Proc., vol. 23, no. 4, Apr. 1926, pp. SC211–SC222. Presentation of general principles of train control bringing out requisites and generalities which may be said to affect all systems.

Three-Speed Train Control on Two Roads Approved. Ry. Signaling, vol. 19, no. 5, May 1926, pp. 197–201. Interstate Commerce Commission issues final reports on Union Switch & Signal Co. installations of Reading Co. and New Jersey Southern division of Central of New Jersey.

Train Stops. N. Y. C. Installs Miller Train Stop. Ry. Age, vol. 80, no. 23, May 8, 1926, pp. 1257–1259, 7 figs. Intermittent inductive type uses inert track elements, mounted at rail level, with check of wayside circuit. See also description in Ry. Signaling, vol. 19, no. 5, May 1926, pp. 176–180, 16 figs.

RAILWAY REPAIR SHOPS

Electrical. Electrical Repair Shop of the Boston and Maine. Ry. Elec. Engr., vol. 17, no. 4, May 1926, pp. 149–151, 5 figs. Practically all repair work for road excepting electric locomotives is done at North Billerica Shops.

Locomotive. Repairing Locomotives at Pennsylvania Railroad Juniata Shop. Ry. Mech. Engr., vol. 100, nos 4 and 5, Apr. and May 1926, pp. 237–245 and 291–296, 22 figs. Apr.: Scheduling system, material delivery, inspection methods and standardized repair parts. May: Utilization of semi-finished parts and micrometers; dimension forms; other machine-shop methods.

RAILWAY SHOPS

Locomotive. Iselin Shop Shows Good Design. Ry. Rev., vol. 78, no. 19, May 8, 1926, pp. 820–823, 7 figs. Plant consists of locomotive machine and erecting shop, storehouse and material yard, wheel shop, power house, etc.

RAILWAY SIGNALING

Automatic Block. A. P. B. Versus Straight Automatic Block Signaling, A. R. Fugina, A. H. McKeen, and E. E. Worthing. Am. Ry. Assn. (Signal Section)—Proc., vol. 23, no. 4, Apr. 1926, pp. SC223–SC238. Discusses absolute permissive automatic block, meaning absolute spacing of trains from passing track to passing track and permissive spacing for following movements; and Harriman system that is used at present; latter has many material advantages over A.B.P. system.

Committee Report on Direct Current Automatic Block Signaling. Am. Ry. Assn. (Signal Section)—Proc., vol. 23, no. 4, Apr. 1926, pp. 663–668. Necessary modifications of d.c. track circuits in detail or in principle, to insure reliable protection of motor buses and cars; preservative treatment of capping and grooved trunking.

Report of Committee on Alternating Current Automatic Block Signaling. Am. Ry. Assn. (Signal Section)—Proc., vol. 23, no. 4, Apr. 1926, pp. 638–663, 2 figs. Protection of low-voltage lines against lightning; inductive interference of a.c. circuits and supply lines for signals and train control with communication circuits; a.c. track-circuit characteristics.

Economics. Report of Committee on Economics of Railway Signaling. Am. Ry. Assn. (Signal Section)—Proc., vol. 23, no. 4, Apr. 1926, pp. 595–617. Operation of trains by signal indication; problems in economics of railway signaling; estimated savings to be effected on 5 divisions of railway system by replacing manual block system with automatic block system; economy of car retarders at hump and gravity yards; classification yards.

Interlocking. Report of Committee on Mechanical Interlocking. Am. Ry. Assn. (Signal Section)—Proc., vol. 23, no. 4, Apr. 1926, pp. 570–579. Electromechanical interlocking machines; application of electric locks and circuit controllers to mechanical interlocking machines using S. & F. locking.

Lamp Standardization. Signal Lamps Standardized, A. H. Handlan. Am. Ry. Assn. (Signal Section)—Proc., vol. 23, no. 4, Apr. 1926, pp. SC250–SC259. Author demonstrates building of lamps from raw sheet of cold-rolled deep-drawn steel through many exacting operations in stamping and drawing presses and special machinery and tools; function and importance of signal lamp.

RAILWAY SWITCHES

Car Retarders. Car Retarders Cut Down Costs. Ry. Rev., vol. 78, no. 15, Apr. 10, 1926, pp. 674–677, 7 figs. Installation at Illinois Central Northbound Yard at Markham is largest in world; includes retarders themselves, power-operated switches and skate-placing mechanisms; control machines, located in 5 elevated towers at various points in yard; power supply, and compressed air. See also Ry. Age, vol. 80, no. 20, Apr. 17, 1926, pp. 1058–1061, 7 figs.

RAILWAY TRACK

Ballast Requirements. Railway Ballast Requirements, F. J. Stimson. Contract Rec., vol. 40, no. 13, Mar. 31, 1926, p. 315. Change in traffic conditions has made different treatment necessary; properties of good ballast; gravel vs. stone.

Grade Reduction. Comparative Economy of Reduction in Ruling Grade and Length of Line, C. A. Morse. West. Soc. Engrs.—Jl., vol. 31, no. 2, Feb. 1926, pp. 41–51 and (discussion) 51–61. Shows that railroads are justified in spending large sums to reduce transportation costs by diminishing heavy grades and sharp curves; each tenth of one per cent of grade eliminated was found to be equivalent to shortening line 4.32 miles.

Steel-Tie. Steel Tie Track Laid by New Method, R. Brokaw. Elec. Traction, vol. 22, no. 4, Apr. 1926, pp. 199–200, 7 figs. Peoria division of Illinois Power & Light Corp. constructs over a mile of double track using steel ties with rails supported on concrete frustum pyramids.

RAILWAY YARDS

Switching. Shunting Yards. Int. Ry. Congress Assn.—Bul., vol. 8, no. 3, Mar. 1926, pp. 244–286. Switching and marshalling yards for freight trains; layout and organization.

REFRACTORIES

Boiler-Furnace. Boiler-Furnace Combustion Chambers of Modern Design (Die Brennkammer für Dampfkesselfeuerungen in neuzeitlicher Bauart), Wintermeyer. Wärme, vol. 49, no. 11, Mar. 12, 1926, pp. 189–192, 2 figs. Refractory requirements of a combustion chamber; use of special refractory bricks, such as carborundum, Spinell brick (with 80 per cent magnesium), Zirkol (zirconium oxide with admixtures), etc., for linings.

REFRIGERATING MACHINES

Absorption. Two New Absorption Refrigerating Machines (Zwei neue Absorptionskältemaschinen), M. Krause. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 18, May 1, 1926, pp. 597–599, 5 figs. Details of Altenkirch machine, and machine of Platen and Munters, both of which eliminate ammonia pump by different means.

Air Removal. Removing Air from Refrigerating Machines (Die Entlüftung der Kältemaschinen), Steinbach. Zeit. für die gesamte Kälte-Industrie, vol. 33, no. 1, Jan. 9, 1926, pp. 1–7, 8 figs. Discusses behavior of gas-air mixtures on coaling in connection with air removal and design of air-removal devices, including Friedmann, Hill, Stein, Riegelmann and Linde types.

Troubles. Some Refrigerating Machine Troubles, C. L. Morgan. Power, vol. 63, no. 19, May 11, 1926, pp. 709–710, 2 figs. Experience of author in operation of combination cold-storage and ice-making plant.

ROLLING MILLS

American. American Rolling Mills (Reiseerfahrungen in amerikanischen Walzwerken), G. Bulle. Berichte der Fachausschüsse der Vereins deutscher Eisenhüttenleute (Walzwerksausschuss), no. 41, for Mtg. Mar. 15, 1925, 12 pp. (including discussion), 15 figs. Impression gained by author on visit to American

rolling mills. Development and operation of blooming mills, bar, tube and wire mills; output and fuel consumption of rolling-mill furnaces.

Cold-Rolling. The Bliss "Cluster" Mill, L. Jones. Blast Furnace & Steel Plant, vol. 14, no. 4, Apr. 1926, pp. 180 and 201. Cold-rolling mill of unusual design for production of high-finish monel metal and nickel sheets at Huntington, W. Va.

Couplings. Mill Type Coupling Design, G. Fast. Iron & Steel Engr., vol. 3, no. 2, Feb. 1926, pp. 100–101, 6 figs. Describes special adaptation of Fast's coupling, manufactured by Bartlett, Hayward Co., Baltimore, Md., to auxiliary steel-mill drives.

Electric Drive. Electrical Rolling Mills, D. W. Blakeslee. Iron & Steel Engr., vol. 3, no. 4, Apr. 1926, pp. 163–167, 10 figs. Deals with rail and structural mills.

Medium and Small-Sized Products. Rolling Mills for Medium and Small-Sized Products, T. W. Hand. Iron & Coal Trades Rev., vol. 112, no. 3033, Apr. 16, 1926, pp. 643–644. Modern 3-high spring-bar mill; mechanical cooling beds; continuous mill at Newport Works; recent American installations; output developments; possibilities of improved practice.

Merchant. Merchant Mills, D. W. Blakeslee. Iron & Steel Engr., vol. 3, no. 2, Feb. 1926, pp. 96–99, 9 figs. Arrangements and methods of increasing output; factors which determine size and type of driving unit for mill; presents list to indicate sizes of motors, with their speeds, used by number of organizations on their merchant mills.

Roll Drives. Main Roll Drives in the United States and Canada. Iron & Steel Engr., vol. 3, no. 1, Jan. 1926, pp. 1–30. Tabulated list of main roll drives installed in iron and steel industry in United States and Canada.

Speed Control. Speed Control in Relation to Modern Rolling Mill Drives, L. Rothera. West of Scotland Iron & Steel Inst.—Jl., vol. 33, Dec. 1925, pp. 24–28 and (discussion) 28–30, 11 figs. Considers questions of best rolling speed for different classes of material; deals with various methods of obtaining variable speed.

Strip Rolling. Steel Strip Rolling at Sandviken (Sweden). Engineer, vol. 141, no. 3669, Apr. 23, 1926, pp. 466–468, 12 figs. partly on p. 470. Deals with Sankvik treatment of strip steel used for making band-saw blades; there are 11 complete sets of hot rolling mills for reducing ingots; process of cold rolling; annealing and trimming, hardening and tempering strip.

Strip Steel and Mills for its Production, N. Jones. Iron & Steel Engr., vol. 3, no. 4, Apr. 1926, pp. 155–163, 15 figs. Use of strip steel; metallurgical and physical requirements; hand-operated mills; semi-continuous mills; modified continuous mills; steam engines replaced by motors; method of rolling; heating furnaces and auxiliary apparatus; sizes of rolls and motors; types of cold-rolling mills; annealing furnaces.

S

SAND, MOLDING

Conditioning. Securing Perfectly Conditioned Sand, F. A. Smith. Can. Foundryman, vol. 17, no. 4, Apr. 1926, pp. 13–14, 1 fig. To secure perfectly conditioned sand, portable sand-cutting machine is commonly used; laboratory tests have revealed that mechanically cut and tempered molding sand has much higher strength and permeability than sand cut and tempered by shovel method.

Mixing. Solving the Unknown Quantity, C. E. McKinney. Can. Foundryman, vol. 17, no. 4, Apr. 1926, p. 15. Points out that mixers of proper type admit of use of lower-priced sands and at the same time keeps binder costs down.

Preparation. Foundry Progress in Sand Preparation, C. D. Hollins. Can. Foundryman, vol. 17, no. 4, Apr. 1926, pp. 20–21. Points to need of thorough study of preparing sand, as well as of reclamation of waste sands and handling systems.

Sand Supplied Continuously. Foundry, vol. 54, no. 9, May 1, 1926, pp. 346–350 and 372, 7 figs. Details of installation of sand-preparation and mold-conveying units in foundry of Packard Motor Car Co., Detroit.

Reclamation. Can Used Sand Be Reclaimed? P. Dwyer. Foundry, vol. 54, nos. 5, 6, 7, 8, 9 and 10, Mar. 1, 15, Apr. 1, 15, May 1 and 15, 1926, pp. 170–172 and 187, 216–219, 265–267, 311–313, 356–358 and 394–398, 3 figs. Results of questionnaire sent to foundries. Facing-sand formulas; shop test; samples of American molding sands; sand-handling equipment; tests on sand; indefinite variety of natural deposits demand widely different treatments; economy is determining factor in methods adopted. Apr. 1: Wide variation shown in proportion of sand to weight of finished castings. Apr. 15: Mechanical testing and control methods to insure mechanical uniformity. May 1: Relative proportion of foundries in which sand control is exercised and manner in which new sand is added. May 15: Equipment and method for reclaiming sand by addition of clay.

Selection. Selecting the Proper Molding Sand, R. Micks. Can. Foundryman, vol. 17, no. 4, Apr. 1926, pp. 14–15. Points out that selection of suitable molding sand is one of most important factors entering into cost of production; mixing and conditioning; machines for cutting, mixing and blending sand.

Steel Castings. The Relationship of Sand to Steel Castings. Research Group News, vol. 3, no. 1, Apr. 1926, pp. 69–76, 5 figs. Origin and characteristics of sand deposits; artifical binders for steel molding sand; handling and mechanical preparation of steel molding sands; importance of sand in steel founding.

Testing. Testing Foundry Sands, C. W. H. Holmes. Brass World, vol. 22, no. 4, Apr. 1926, pp. 122–124. Formation of sands; dry sieving methods; coagulation phenomenon; limitation of test values.

SEMI-DIESEL ENGINES

Peugeot-Tartrais. The Latest Semi-Diesel. Motor Transport (Lond.), vol. 42, no. 1101, Apr. 5, 1926, pp. 433–434, 5 figs. Details of Peugeot-Tartrais heavy-oil engine as developed for commercial production.

SHEARS

Knives. Mangan. Steel Shear Knives for Hot Work, E. R. Norris. Blast Furnace & Steel Plant, vol. 14, no. 4, Apr. 1926, pp. 195 and 200. In general, manganese steel shows superiority over tool steels for hot shearing in less material required, in lower cost per pound, in less labor and machine work in preparation, in requiring no heat treatment, etc.

SMOKE

Formation and Prevention. Smoke—Its Formation and Prevention, C. F. Wade. Elec. Times, vol. 69, no. 1799, Apr. 8, 1926, p. 451. Discusses causes of loss of heat; points out that black smoke is source of soot deposit on heating surfaces of economizers so that, apart from direct heat losses in gases when this smoke is present, heat-transfer process will be appreciably retarded by deposit of layer of material of very high efficiency as heat insulator.

SPRINGS

Helical. Formulas for the Design of Helical Springs of Square or Rectangular Steel, C. T. Edgerton. Mech. Eng., vol. 48, no. 5, May 1926, pp. 484–487 and (discussion) 491. Points out lack of formulas for calculating any except springs of square bar steel in work of St. Venant; for solution of these formulas author gives tabulated values for two variables which depend on ratio of bar's cross-sectional dimensions.

Phosphor-Bronze Helical Springs from the Standpoint of Precision Instruments, W. G. Brombacher. Mech. Eng., vol. 48, no. 5, May 1926, pp. 488–491 and (discussion) 493 and 494, 5 figs. Results of tests made at Bureau of Standards to obtain knowledge useful in design of springs for precision instruments; sets forth characteristics of spring material, method of construction, apparatus in which springs were tested and procedure followed; results relate to stiffness, maximum fiber stress, hysteresis, after-effect, drift and buckling.

Shock-Absorbing. Factors of Design of Shock-Absorbing and Recuperating Steel Springs, T. M. Jasper. Mech. Eng., vol. 48, no. 5, May 1926, pp. 487–488 and (discussion) 491–492, 4 figs. Factors of design of metal used for shock-absorbing purposes and for recuperating machinery; problem of design of springs is divided into (1) static elastic and fatigue properties of material to be used in their construction, (2) shape of springs, together with distribution of stresses developed in their use for given deformation.

STANDARDIZATION

Germany. Standardization of Materials and Its Importance for Producers and Consumers (Die Werkstoffnormung und ihre Bedeutung für Erzeuger und Verbraucher), L. Glück. Maschinenbau, vol. 5, no. 6, Mar. 18, 1926, pp. 252–255, 1 fig. System of standards and symbols for iron and steel and non-ferrous groups; methods of testing; profiles and dimensions, tolerances, etc.

International. International Standardization (Internationale Normung), K. Gramenz. Maschinenbau, vol. 5, no. 6, Mar. 18, 1926, pp. 249–251. Compares national and international aspects, and discusses prospects of international action on standards for screw threads, ball bearings, fits, grinding disks, automobile construction, etc.

Rules. Modifications of Rules in German Industrial Standardization (Gesetzmässigkeiten in der deutschen Industrienormung), Portsmann. Werkstattstechnik, vol. 20, no. 7, Apr. 1, 1926, pp. 217–220. Based on German industrial standards, three laws for standardization are derived and investigated, namely, law of equality, law of similarity, and law of grading.

STANDARDS

Austrian Oe.N.I.G. Reports. Report of the Austrian Industrial Standards Committee (Normblattentwürfe), Sparwirtschaft, no. 1, Jan. 1926, pp. N1–N8, 7 figs. Proposed standards for properties of high-grade portland cement; for inscribing dimensions and tolerances in drawings; and for symbols to specify operations and types of materials, etc.

Report of the Austrian Industrial Standards Committee (Normblattenwürfe), Sparwirtschaft, no. 3, Mar. 1926, pp. N33–N35, 2 figs. Proposed standards for position and movement of operating levers for automobiles; loading of brick and masonry work in building construction.

German N.D.I. Reports. Report of German Industrial Standards Committee (NDI-Mitteilungen), W. Reichardt. Maschinenbau, vol. 5, no. 6, Mar. 18, 1926, pp. 285–290. Proposed standards for various types of hose couplings for fire department; sizes for paper supplied by paper manufacturers.

Report of German Industrial Standards Committee (NDI-Mitteilungen), W. Reichardt. Maschinenbau, vol. 5, no. 7, Apr. 1, 1926, p. 337. Proposed standards for technical gases for use as fuel; various types of chucks, jaws, and feeds for automatic turret lathes.

STEAM

Adiabatic Expansion. Relations between Heat of Expansion and Elasticity and Specific Heat (Su alcune relazioni tra le calorie di dilatazione e di elasticita e i calori specifici), R. Palladino. Rivista marittima, vol. 58, no. 11, Nov. 1925, pp. 409–420 and vol. 59, no. 2, Feb. 1926, pp. 491–504. Develops new formulas for expressing adiabatic expansion of steam, and application to perfect gases and saturated steam.

High-Pressure. The Löffler High-Pressure Steam System, C. S. Darling. Power Engr., vol. 21, no. 242, May 1926, pp. 169–170, 1 fig. Principle of Löffler system of steam generation is one of most radical departures from orthodox practice and at one sweep avoids troubles which are now experienced with what in future will be regarded as low-pressure boilers; factories using process steam economically and effectively adopt this system of generation up to 100 atmos. and if necessary over this.

Natural, from Geysers. Natural Steam for Developing Electricity, C. W. Geiger. Power Plant Eng., vol. 30, no. 10, May 15, 1926, pp. 607–609, 7 figs. Healdsburg Geysers in Sonoma County, California, are being drilled to furnish steam at 62 to 276 lb. for driving turbines.

Superheat and Reheat. Superheat and Reheat, B. N. Broido. Power, vol. 63, no. 20, May 18, 1926, pp. 757–759, 7 figs. Author reviews reasons for using superheat and reheat, discusses design problems showing that superheater must withstand severe operating conditions; describes three schemes for reheating low-pressure steam.

STEAM GENERATION

Rapid and High-Pressure. New Methods of Rapid and High-Pressure Steam Generation (Neue Wege der Schnell- und Hochdruckdampferzeugung), Wintermeyer. Feuerungstechnik vol. 14, nos. 7 and 8, Jan. 1 and 15, 1926, pp. 74–77 and 86–90, 16 figs. Arguments in favor of further development, and how this may be accomplished with aid of different types of evaporators and with steam generators of superheated water, and circulating steam generators.

STEAM METERS

Electrophysical. Electrophysical Measurement of Steam (Elektrophysikalisches Dampfmesserprinzip), Wittenhaus. Elektrotechnischer Anzeiger, vol. 43, no. 14, Feb. 17, 1926, pp. 163–165, 3 figs. Discusses principle of measuring steam flow by means of orifices, nozzles or venturi tubes and gives chart for graphic calculation.

Flow Measurement. Modern Practice in Steam Flow Measurement, M. A. Goetz. Power Plant Eng., vol. 30, no. 9, May 1, 1926, pp. 518–520, 4 figs. Advantages and use of flow indicators.

STEAM PIPE

Insulation. Value of Insulation for Steam Pipe Lines (Der Wert der Isolation von Dampfleitungen), P. Wiegleb. Wärme- & Kälte-Technik, vol. 28, no. 6, Mar. 20, 1926, pp. 60–62, 1 fig. Discusses heat loss by radiation, calculation of radiation coefficient, efficiency of insulation; kieselguhr as insulating material; advocates an air cushion of 15 mm. thickness as most effective.

STEAM POWER PLANTS

Bleachery Mill. Southern Bleachery Installs Steam Plant in Hydro-Electric District. Power, vol. 63, no. 17, Apr. 27, 1926, pp. 626–629, 7 figs. Combined power and steam-heating plant; installed in new bleachery mill at Taylor, S. C.; horizontal tubular boilers and superheaters are used; steam is extracted from 750-kw. turbine at 40-lb. gage.

Design. Designing a 500-Horsepower Steam Power Plant, C. L. Hubbard. Southern Power, Jl., vol. 44, no. 4, Apr. 1926, pp. 50–55. Steam requirements; type of prime mover; boiler capacity; condensing and furnace equipment; chimney and smoke breeching; feedwater heaters and purifiers; water piping.

STEAM TURBINES

Design Tendencies. Tendencies in Steam Turbine Design. Power Plant Eng., vol. 30, no. 9, May 1, 1926, pp. 525–528, 4 figs. Review of situation discloses many interesting developments; use of turbines of special design; possible increased ratings from existing turbines; potential capacities of turbines designed for regenerative cycle; operation of mercury-vapor turbine at Hartford. (Abstract.) Serial report of Prime Movers Committee of Nat. Elec. Light Assn.

Extraction. High Load Factor and Process Steam Demand Enables Extraction Turbine to Save Over $50,000 a Year, H. W. Gochnauer. Power, vol. 63, no. 19, May 11, 1926, pp. 706–708, 2 figs. Paper mill installed 2000-kw. extraction-type turbo-generator and in about 3 years saved cost of unit with all auxiliary equipment and expense of changing over 250 motors from 25 to 60 cycles at time turbine was installed.

Reaction Blading. Efficiency of Reaction Blading for Steam Turbines. Power, vol. 63, no. 15, Apr. 13, 1926, p. 553. Results of tests conducted by Stodola on Brown-Boveri high back-pressure turbine show efficiency reaching 80 per cent. Abstract translated from Génie Civil, Mar. 6, 1926, p. 228.

Research. Investigation and Research Relating to the Steam Turbine, G. B. Warren. Wis. Engr., vol. 30, no. 6, Mar. 1926, pp. 187–189, 212 and 216, 2 figs. Résumé of research work carried on during past few years by Gen. Elec. Co. relating to steam elements of large steam-turbine construction.

Steam Consumption and Efficiency. Steam Consumption and Efficiency of Steam Turbines (Dampfverbrauch und Wirkungsgrad von Dampfturbinen), G. Forner. Zeit. des Vereines deutscher Ingenieure, vol. 70, no. 15, Apr. 10, 1926, pp. 502–508, 6 figs. From results of tests on turbines which represent best values obtained up to end of 1925, empirical equations for steam consumption and efficiency of condensing steam turbines are derived; results of steam-consumption tests on back-pressure turbines; calculation of degree of efficiency to be expected from increase, of initial pressure above 20 atmos.

STEEL

Alloy. See ALLOY STEELS.

Cold Drawing. The Cold Drawing of Bar Steel

F. W. Krebs. Mech. Eng., vol. 48, no. 5, May 1926, pp. 448–450, 8 figs. Various steps involved in converting hot-rolled steel into cold-drawn bars; equipment used; factors affecting machining quality of steel; effects of cold drawing upon physical properties.

Corrosion. Corrosion of Steels in the Atmosphere, W. G. Whitman and E. L. Chappell. Indus. & Eng. Chem., vol. 18, no. 5, May 1926, pp. 533–535, 3 figs. Method of rapid testing for atmospheric corrosion, in which primary accelerating influence is moisture; test has given results within few days comparing favorably with results of long-time service tests on some steels by Am. Soc. Testing Matls.

Forgeability. Forgeability of Steel Determined by the Brinell Machine, R. E. Kerslake. Am. Soc. Steel Treating—Trans., vol. 9, no. 5, May 1926, pp. 773–776, 5 figs. Presents rapid, inexpensive and efficient method of testing steel bar stock as to its suitability for either hot or cold forging or upsetting; hardened steel cone is substituted for 10-mm. ball of usual-type Brinell testing machine.

Sheet. Sheet Steel—Specification and Inspection, L. N. Brown. Blast Furnace & Steel Plant, vol. 14, no. 5, May 1926, pp. 206–212. Testing for drawing qualities; ductility test; gage and size tolerances; tabulated data giving results of ductility tests.

Tool. See TOOL STEEL.

STEEL, HEAT TREATMENT OF

Dilatometric Equipment. Volcrit Method of Heat Treatment by the Rockwell Dilatometer. West. Machy. World, vol. 17, no. 4, Apr. 1926, pp. 154–155 and 179, 3 figs. Details of Rockwell dilatometer and advantages of its use for heat treatment.

Hardening, Effects of. Facts and Principles Concerning Steel and Heat Treatment, H. B. Knowlton. Am. Soc. Steel Treating—Trans., vol. 9, no. 5, May 1926, pp. 781–792. Reviews some of points brought by other writers concerning distortion, warping, and cracking, and brings out practical applications; discusses changes in shape, in volume, effect of composition of steel, temperature, different methods of heating and quenching.

Nickel Steel. Heat-Treatment for Nickel Steels. Am. Mach., vol. 64, no. 17, Apr. 29, 1926, p. 683. Reference-book sheet on treatment for annealing or hardening nickel steels.

Quenching. Mass Effects in Quenching. Fuels & Furnaces, vol. 4, no. 4, Apr. 1926, pp. 435–438, 3 figs. Effect of size and shape of object and quenching temperature on center cooling velocity.

Reheating, Effect of. Effect of Reheating on Cold Drawn Bars, S. C. Spalding. Am. Soc. Steel Treating—Trans., vol. 9, no. 5, May 1926, pp. 685–707 and (discussion) 707–716 and 780, 23 figs. Deals with three steels, a carbon-manganese, a 3.50-per cent nickel and a chromium-vanadium, all 0.20 to 0.30-per cent carbon; yield points for manganese and chromium-vanadium steels are considerably increased after cold drawing and reheating to 600 deg. fahr.; tensile strength is only slightly increased; there is a slight loss in ductility and notched-bar toughness; at 100 and 1200 deg. fahr., yield point and tensile strength are reduced to their initial figure.

STEEL MANUFACTURE

Electric Melting. Progress in the Electric Melting of Steel (Fortschritte im Elektrostahlschmelzen), G. Mars. Giesserei-Zeitung, vol. 23, nos. 5 and 6, Mar. 1 and 15, 1926, pp. 117–120 and 154–156 and (discussion) 156–159. Comparison, from viewpoint of economy, of electric-furnace melting with melting in crucible and open-hearth furnace and converters, showing superiority of electric steel.

Ingots, Large. Chemical Analyses of Large Ingots, J. H. Hruska. Iron Age, vol. 117, no. 15, Apr. 15, 1926, pp. 1049–1050. Facts as to inclosures and gases more vital than strict chemical specifications; melting practice and analysis both important; basic, acid, and refined open-hearth ingots; basic and acid electric steel ingots.

Tool Steel. Making High Grade Steel, J. A. Coyle. Iron Trade Rev., vol. 78, no. 18, May 6, 1926, pp. 1177–1179, 5 figs. Manufacture of tool steel; includes table showing kind of steel used for many of important tools used in industry.

STELLITE

Application to Metal Parts. Stelliting of Metal Parts. Oxy-Acetylene Tips, vol. 4, no. 10, May 1926, pp. 177–179, 3 figs. New process of applying stellite to metal surfaces which are called upon to withstand heat, abrasion or corrosion. See also description in Machy. (N. Y.), vol. 32, no. 9, May 1926, pp. 687–690, 8 figs

STOKERS

Underfeed. Recent Underfeed Stoker Developments. Power, vol. 63, no. 20, May 18, 1926, pp. 751–753, 6 figs. Outlines losses chargeable to stoker and shows how recent developments serve to reduce these losses.

STROBOSCOPES

Rotoscope. The Ashdown Rotoscope. Mech. World, vol. 79, no. 2051, Apr. 23, 1926, pp. 319–320, 3 figs. Details of new form of stroboscope which completely solves difficulties of adequate illumination, sharp definition and small size, and affords further advantage of binocular vision.

Stroborama. The Stroborama, A New Apparatus for Studying Mechanism in Motion (Le stroborama, nouvel appareil stroboscopique à grand éclairage, ses applications industrielles), Laurent and A. Seguin. Société d'Encouragement pour l'Industrie Nationale —Bul., vol. 125, no. 2, Feb. 1926, pp. 81–94, 4 figs.; also translated abstract in Engineer, vol. 141, no. 3670, Apr. 30, 1926, p. 506, 1 fig. Instrument belongs to order of stroboscopes in which vision occurs owing to instantaneous flashes of light, but instead of employing a spark, inventors use tube filled with neon gas, and by ingenious arrangement, such high local illumination is produced that moving parts may be studied in ordinary light of room.

T

TAPS

Drill Sizes. The Development of Tap-Drill Sizes, A. C. Danekind. Mech. Eng., vol. 48, no. 5, May 1926, pp. 445–448, 5 figs. Results of effort made to devise practical tap drill for production purposes for commonly used materials.

TEMPERATURE MEASUREMENT

Instruments. Test Code on Instruments and Apparatus. Mech. Eng., vol. 48, no. 5, May 1925, pp. 517–526, 16 figs. Preliminary draft of chapter 3, temperature measurement, part 2—glass thermometers.

TERMINALS, LOCOMOTIVE

Battle Creek, Mich. Grand Trunk Western Builds Modern Terminal at Battle Creek. Ry. Age, vol. 80, no. 22, May 1, 1926, pp. 1197–1200, 5 figs. Details of enginehouse, power plant, office and stores building and outside facilities.

Hampton, Pa. D. L. & W. Engine Terminal at Hampton, M. R. Feeley. Ry. Mech. Engr., vol. 100, no. 5, May 1926, pp. 297–301, 7 figs. Equipped with inspection sheds, ash pits, gravity coal chutes and other mechanical features of improved design.

TESTING MACHINES

Universal. A New Universal Testing Machine. Engineer, vol. 141, no. 3668, Apr. 16, 1926, p. 446, 3 figs. partly on p. 442. Multiple-lever machine capable of testing in tension, deflection or compression any description of materials from nickel-chrome steel to timber.

TEXTILE MACHINERY

Cotton Spinning. Saco-Lowell Long Draft Systems. Textile World, vol. 69, no. 15, Apr. 10, 1926, pp. 63 and 73, 4 figs. Two new devices for cotton spinning; LeBlan-Roth apron system and four-roll drafting system.

TEXTILE MILLS

Group Drive. Group Drive Economy in Modern Textile Mills, L. H. Hopkins. Belting, vol. 28, no. 4, Apr. 1926, pp. 11–14. Saving effected by present-day methods; selection and installation; transverse and torsional strain.

THERMOMETERS

Resistance, Installing. Installing Electric Temperature-Measuring Instruments (Ueber den Einbau der elektrischen Temperaturmessgeräte), M. Moeller. Siemens Zeit., vol. 6, no. 2, Feb. 1926, pp. 65–72, 10 figs. Discusses errors in mounting thermometers and thermocouples, due to instruments interfering with temperature of medium to be measured, or to faulty indication because of heat transmitted by thermometers; makes calculations to determine these errors and gives examples.

TIME STUDY

Analyst, Functions of. The Functions of the Time Study and Methods Analyst, H. B. Maynard. Am. Mach., vol. 64, no. 18, May 6, 1926, pp. 729–731. Relation of analyst to various departments; his qualifications.

Computation. Computing Relative Speeds of Work to Save Time Study Expense, R. Mawson. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 371–372. When analyzing machining operations from which time studies are to be compiled, it is customary to obtain as one of primary functions best speeds with which various metals may be machined, and along with this, proper feeds; when this data has been obtained, it is easy matter to compute by proportion other time studies for any other sizes of machine parts made from similar metal.

Piece Work. Determining Time for Piece Work (Einige Betrachtungen zur Zeitermittlung bei Akkordarbeit), K. Gottwein. Maschinenbau, vol. 5, no. 7, Apr. 1, 1926, pp. 297–300, 7 figs. Discusses relation between worker and his work, tools and machines; difficulties of time study due to varied conditions and combinations of these.

TIRES, RUBBER

Balloon. Balloon Tires for Motorcoaches, J. M. Linforth. Soc. Automotive Engrs.—Jl., vol. 18, no. 5, May 1926, pp. 477–478. Tests have shown greater mileage for low-pressure than for high-pressure tires, and experience seems to indicate that they will give at least as much mileage as the latter in regular service.

V

VALVES

Hydraulic. New Developments in Hydraulic Valves (Neuerungen an Abschlussorganen von Turbinenanlagen), R. Löwy. Elektrotechnik u. Maschinenbau, vol. 43, no. 43, Oct. 25, 1925, pp. 841–846, 13 figs. Discusses problem from viewpoint of hydraulic turbines and their pipe lines; type of valve must be designed in accordance with its function; describes new type, known as spherical slide valve, built by Escher, Wyss & Co., which is combination of cock or rotary slide valve and poppet principles; for control of pressure and for by-passes, piston valves are almost universally used, and several new types are described, some of which are operated automatically and hydraulically for regulating purposes; one, a double-beat valve, made by Loebersdorf Maschinenfabrik, is operated by crank and connecting rod.

Pipe-Line Air-Inlet. Pipe-Line Air-Inlet Valves, J. W. Ledoux. Mech. Eng., vol. 48, no. 5, May 1926, pp. 467–469. Prevention of collapse due to reduced internal pressure; detailed calculation of number of air valves required in pipe line having sections of different gradients and diameters.

VARNISHES

Tung Oil. Quick Drying Tung Oil Varnish Paints, H. A. Gardner. Paint Mfrs.' Assn. U. S.—Sci. Section, circular no. 264, Apr. 1926, pp. 411–413. Results of laboratory experiments which indicate color, body, drying time and toughness of some rapidly drying varnishes.

VENTILATION

Buildings. Artificial Ventilation of Buildings (Künstliche Regelung der Luftbeschaffenheit in Gebäuderäumen), M. Hirsch. Gesundheits-Ingenieur, vol. 49, no. 13, Mar. 27, 1926, pp. 188–194, 6 figs. Conditions conducive to comfort, and their determination; temperature and humidity; purification, cooling, and heating of air; air-conditioning apparatus, etc.

VIBRATIONS

Synchronous. Notes on the Demonstration of Synchronous Vibration and Critical Speed, R. T. Liddicoat. Mich. Technic, vol. 39, no. 3, Mar. 1926, pp. 17–18 and 23, 1 fig. Summary of underlying theory and demonstration.

W

WAGES

Barth Standard Scale. The Barth Standard Wage Scale. Mfg. Industries, vol. 11, no. 5, May 1926, pp. 373–374. Discussion by C. D. Demond and reply by C. G. Barth.

Bonus Systems. See BONUS SYSTEMS.

WASTE ELIMINATION

Industrial. Organization of a National Committee to Study Practical Methods for the Elimination of Waste. Soc. Indus. Engrs.—Bul., vol. 8, no. 3, Mar. 1926, pp. 2–10. Purpose of committee is to promote interest in elimination of waste in management, manufacturing, distribution, national resources and government.

WATER ELEVATORS

Continuous Machine. Continuous Water-Lifting Machine. Engineering, vol. 121, no. 3139, Feb. 26, 1926, p. 278, 3 figs. Water-raising machine erected at Dorking by Hydroautomat, Ltd., London; it is automatic in action and has no valves or any moving part.

WATER PIPE

Friction. An Easy Method to Determine Friction Losses in Water Pipe, F. J. Walter. Ry. Eng. & Maintenance, vol. 22, no. 5, May 1926, pp. 181–182, 3 figs. Presents charts from which friction losses can be determined readily, both for straight pipe and standard elbows and tees; charts cover only those sizes of pipe which are usually encountered in railway water-service work.

WATER POWER

France. Water Power in France. Engineering, vol. 121, no. 3148, Apr. 30, 1926, p. 550. Brief review of developments in 1925; outline of what has been, and is being accomplished, based on water-power year book, issued by Revue Générale de l'Electricité.

WELDING

Electric. See ELECTRIC WELDING, ARC.

Wire Specifications. Welding Wire Specifications, F. E. Burk. Welding Engr., vol. 2, no. 4, Apr. 1926, pp. 33 and 36. Points out that only small number of specifications have so far been accepted as standard, and discusses advisability of providing greater number of standards.

WIND TUNNELS

Turbulence in. Investigation of Turbulence in Wind Tunnels by a Study of the Flow about Cylinders, H. L. Dryden and R. H. Heald. Nat. Advisory Committee for Aeronautics—Report, no. 231, 1926, pp. 3–17, 19 figs. Describes two methods of making studies of turbulence, together with results of their use in 54-in. wind tunnel of Bureau of Standards; first method consists of measuring drag of circular cylinders; second, in measuring static pressure of some fixed point; both methods show that flow is not entirely free from irregularities.

WINDING ENGINES

Steam. Steam Winding-Engines and Accumulators, H. Pilling. Instn. Min. Engrs.—Trans., vol. 71, Mar. 1926, pp. 63–79 and (discussion) 79–87, 27 figs. Steam winding equipment laid down by Wigan Coal & Iron Co. at Parsonage Pit, Leigh.

WINDMILLS

Electric-Power-Plant. Electric Wind-Power Stations (Elektrische Windkraftzentralen), Foerster. Elektrotechnischer Anzeiger, vol. 43, no. 25, Mar. 27, 1926, pp. 299–304, 12 figs. Discusses available wind power per year; types of windmills for driving generators; storage batteries, and power-plant arrangement for central stations or isolated estates.